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STATE SUPERINTENDENT

[illegible]

IRRIGATION AND FORESTRY

[illegible]

GOVERNOR OF [illegible]

DECEMBER 1, [illegible]

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THIRD ANNUAL REPORT

—OF THE—

STATE SUPERINTENDENT

—OF—

IRRIGATION AND FORESTRY

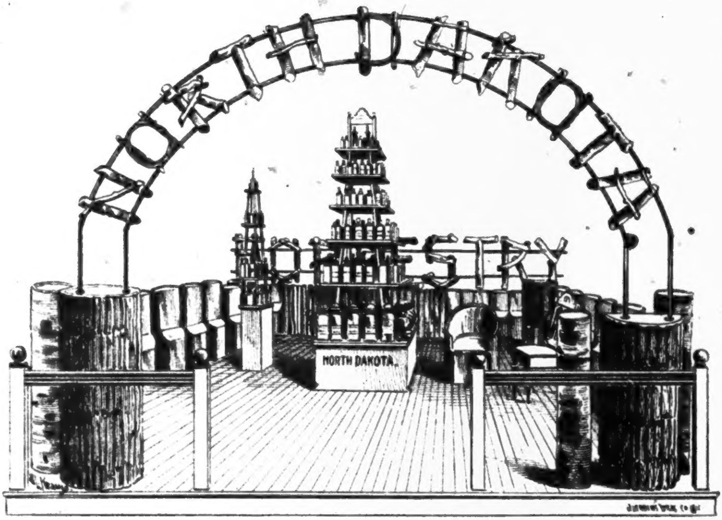
—TO THE—

GOVERNOR OF NORTH DAKOTA,

—FROM—

DECEMBER 1, 1892, TO DECEMBER 1, 1893.

JAMESTOWN, N. D.
ALERT, STATE PRINTERS AND BINDERS.
1894.


NORTH DAKOTA
FORESTRY
NORTH DAKOTA.

VIEW OF NORTH DAKOTA SYLVATAN EXHIBIT AT THE WORLD'S COLUMBIAN FAIR, HELD IN CHICAGO, ILLINOIS, IN 1893.

IRRIGATION AND FORESTRY

Are intimately correlated, and scientifically and intelligently developed together will insure the highest status of agricultural and horticultural pursuits for the beneficent good of humanity.

COMPLIMENTS OF THE AUTHOR.

March 21/95

LETTER OF TRANSMITTAL.

STATE OF NORTH DAKOTA,
DEPARTMENT OF IRRIGATION AND FORESTRY,
BISMARCK, N. D., Dec. 1, 1893.

HON. E. C. D. SHORTRIDGE,
Governor of North Dakota:

DEAR SIR:—In accordance with the requirements of the law, I have the honor to submit herewith my third annual report as the State Superintendent of Irrigation and Forestry of North Dakota.

I trust the facts and views herein contained may tend towards a better understanding and a fuller development of Irrigation and Forestry, fraught with the best welfare of our State and people.

Yours Respectfully,
W. W. BARRETT,
State Superintendent of Irrigation and Forestry.

SUPERINTENDENT'S REPORT.

INTRODUCTION.

Irrigation, meteorology, forestry and kindred subjects, which are involved in this department of State service, are each and all of paramount importance, and all are intimately and inseparably correlated. And it was an act of legislative wisdom, based upon a knowledge of natural laws and operations, on the part of our law makers, who in harmony with the light of science, evolved in the last few years, combined in one office these co-relating subjects, the principles and proper application of which cannot but conduce to the development of the natural resources and productive qualities of our state and the material welfare and happiness of our people.

IRRIGATION IN ITS MOST COMPREHENSIVE SENSE

embodies the idea of water, its laws and its office, especially in its application to the soils and plants for the benefit of cultural pursuits. It is one of the chief elements in the economy of nature. It constitutes the largest area of the earth's surface, embodies a large proportion of the minerals and the animal and plant life of the globe, and pervades in limitless extent its surrounding atmosphere. No art, no pen, no type nor tongue can portray its necessity, its use and blessings. Without it all animal and plant life would expire, and the earth become a barren waste—the mockery of the non-existence of nature's essential element.

Its indispensable use, its profitableness and benificent results in the husbandry of life or the cultural industries of men, are some of the chief things that have, and of a necessity will continue to receive the attention of this department.

THE SCIENCE OF METEOROLOGY

has its specific claims. It is paramount to many and it is second to no other. In its full comprehensive signification it involves many of the laws and operations of the elements of the land, water and the air. It deals with the causes, the phenomena, influences and effects of all things involved in and relating to its jurisdiction. Thus it embraces many things that pertain to waters on, in and above the earth, to heat and cold, sunlight, the tides, the hail, the frost, the rain, the air, the wind, the tornadoes, the earthquakes, electric influences, all natural harmonious operations and disturbances in earth and the atmosphere, and all things whatever that adhere in and are inseparable from, and affect the climate and weather.

No power of language can express the transcendent importance of the science of meteorology. And to aid in the proper evolvement of the same for practical beneficial uses in all the affairs of human life, particularly in the direction of agricultural, horticultural and forestal pursuits, is one of the duties pertaining to this department.

THE USEFULNESS OF FORESTRY.

No commoner, no orator, no statesman and no gifted scholar has or can reveal the absolute necessity and beneficent advantages of forestry. Viewed in all its aspects, or examined from all standpoints, economic, sanitary, æsthetic or otherwise, we find the great lesson taught is *usefulness, material aid and blessings, to the individual and the masses.*

Tho forests of the Union, all told, constituting near 450,000,000 acres, yield 24,000,000,000 cubic feet of wood material per annum; giving an approximate value of $1,000,000.000.00, more than the total value of annual crop of wheat, rye, oats, potatoes, cotton and tobacco produced in the United States, and thirty-three per cent. more than the value of all exports each year, on an average, of every kind from our great country. This material benefit is deserving of profound consideration.

SUSTENANCE OF MAN AND BEAST.

We have in North Dakota nearly 500.000 acres of forest land, native and domestic, but in order to produce the most favorable climatic, water and crop conditions, we should have at least 12,000,000 acres, or one quarter of our state devoted to forestry. Thus our profits on cultural pursuits would be increased, and the woods made to yield great wealth, and to furnish material for all the wants and necessity of the millions yet to inhabit our commonwealth, which, by this great economic development, the state will reach its highest eminence, and wealth, comfort and happiness come unto the people.

It is the duty, as it should be the pleasure, of those who may have charge of this department to assist in the conservation of our present forests and the development of more, for the good of our state and denizens thereof.

ACKNOWLEDGMENTS.

Many sympathetic and encouraging words have been extended and aid rendered to the writer by the friends of this department, and I take pleasure indeed in acknowledging such courtesies from the following gentlemen and ladies: Hon. E. C. D. Shortridge, governor of the state; Orr Sanders, private secretary; all the state officers; Hon. H. C. Hansbrough and Hon. W. N. Roach, United State senators; Hon. M. N. Johnson, representative to congress; Hon. Edwin Willits, assistant secretary of agriculture; Hon. J. Sterling Morton, secretary of agriculture; Hon. Mark W. Harrington, chief of weather bureau; Prof. B. E. Fernon, chief of forestry division agricultural department; Edward E. Bowers, of United States general land office; Dr. N. E. Egleston, corresponding secretary American Forestry association; Prof. F. H. Newell, of United States geological survey; Editors Irrigation Age; Hon. J. O. Barrett, secretary Minnesota State Forestry Association; editors of our state press; E. W. Haseltine, Oscar H. Will, James Holland, Burgh Bros., nurserymen of North Dakota; W. J. Woods, Prof. Robert Hay, Hon. Alfred Dickey, executive manager and all other members of the North Dakota World's Fair Board; Miss Emma C. Crans, secretary of the North Dakota State Sylvatan Society, and Miss Hannah Holton, executive committee of same; Miss E. Theresa Morden, A. S. Capehart and many others.

Irrigation will make the desert lands of the west the home lands for the east.

STATE LAWS

RELATING TO IRRIGATION AND FORESTRY IRRIGATION.

Below, as a matter of convenience for those seeking a knowledge of the same, I give a copy of all the laws in regard to irrigation and forestry, which have been passed since North Dakota became a state:

TAX FOR IRRIGATION PURPOSES.

An Act to Allow Organized Townships to Raise a Tax for Irrigation Purposes.

Be it Enacted by the Legislative Assembly of the State of North Dakota:

SECTION 1. Whenever ten (10) legal voters of any organized township petition the town board fifteen (15) days previous to any annual town meeting to submit the question of irrigation, by building dams to create ponds or reservoirs on any of the creeks or coulees in said township, it shall be the duty of said town board to submit the question to the voters at the next annual town meeting, and the town clerk shall cause three (3) notices to be posted specifying the place and nature of said improvements.

SEC. 2. Whenever two-thirds of the legal voters of any organized town in this state, at their annual town meeting agree that it is advisable and for the public good that certain specified creeks or coulees should be improved to increase the water supply and for the purpose of irrigation, it shall be lawful for such voters to levy a tax upon said town, to be expended in building dams to create ponds and reservoirs, by and under the direction of the board of supervisors of said town; provided, such improvements shall be wholly in said town; provided, further, that no lands shall be flooded without the consent of the owner or without a just compensation therefor, which compensation shall be determined by arbitration.

Sec. 3. The tax authorized to be levied by section one (1), shall not exceed two (2) mills on the dollar of assessed valuation of said town.

Sec. 4. There being an emergency existing by reason of the fact that the annual town meetings are held in March of each year, this act shall take effect and be in force from and after its passage and approval.

Sec. 5. All acts or parts of acts in conflict with this act are hereby repealed.

Approved February 11, 1890.

TO ENCOURAGE CONSTRUCTION OF ARTESIAN WELLS.

[S. B. No. 148.]

An Act to Encourage the Construction of Artesian Wells and Defining the Rights and Liabilities of Persons, Corporations and Companies Constructing said Wells for the Purpose of Power and for the Purpose of Irrigating Agricultural Lands.

Be It Enacted by the Legislative Assembly of the State of North Dakota:

Section 1. It shall be lawful for any person or persons, or association of persons, to construct artesian wells upon any lands owned or leased by them for the purpose of power, or the irrigation of lands for the purpose of agricultural purposes, and for any and all purposes for which said water from such wells may be utilized.

Sec. 2. When any person, persons or association of persons shall desire to dispose of any surplus water from any artesian well, pond or storage reservoir, he or they shall make application to the county court in and for the county in which the lands over or through which it is desired to conduct such waters, for an order for a hearing to determine whether any lands over which such water is proposed to be conducted, will be damaged to any extent beyond the resultant benefit, and if so, to what extent.

Sec. 3. At the time of applying for, and the issuing of such order, the judge of the county court shall also issue notices to the party or parties whose lands are affected, to appear and be heard at the time of such hearing, and prove any damage that the proposed water will incur to him or them; such notices shall be served by the sheriff or any other officer authorized to serve processes in civil cases.

SEC. 4. The order for hearing shall issue at least ten (10) days prior to the day upon which the hearing is to be held, and if the person or persons whose lands are affected, can show by affidavit that they are not ready to be heard, an adjournment may be taken for a period not exceeding ten (10) days, when the hearing must take place; and if the judge determine that the damage will be in excess of the resultant benefit, he shall issue his order to the party or parties seeking such damage [drainage] directing such party or parties to pay such amounts as he may find and determine to the person or persons over whose land the drainage is to be had; *Provided*, That no routes for waterways shall be located without the written consent of the owner, within fifteen rods of the dwelling house, or other buildings on the premises, or across any orchard or garden, without such written consent.

SEC. 5. In drawing any surplus waters from any artesian well, pond or storage reservoir, over any adjacent lands, they shall be confined in a ditch or drain not exceeding four (4) feet in width, unless the party or parties otherwise agree. The party or parties obtaining the drainage shall provide reasonable means of crossing any ditch constructed by him or them, in as many places as may be determined necessary by the county judge at the time of holding hearing.

SEC. 6. In estimating the amount of damage, if any, on account of drainage, the judge shall take into consideration any benefit that may accrue to the party or parties over whose land or lands the drainage is affected by reason of the moisture furnished by the flowing water; and if the benefit, in the judgment of the court, is equal to the amount of damage, if any, then the court shall order that the drainage shall be given without compensation; *Provided*, That either party, feeling aggrieved by the decision of the county court, may appeal to the district court, in and for the district wherein said lands are located, in such manner as is or may be provided by law for appeals, and the amount of such damages upon the appeal, when demanded by either party, shall be determined by jury, and the question of damages shall be tried as in other civil cases; *Provided, further*, That the construction of said waterways or ditches shall not be delayed by the appeal if the amount of the damages assessed shall be deposited with the clerk of said district court, together with a sufficient bond to be approved by said clerk, conditioned to pay any excess that may be adjudged by said district court.

SEC. 7. Whenever it is necessary to construct a waterway from an artesian well, pond or storage reservoir across the right of way of any railroad company, it shall be the duty of said railroad company, when notified by the party or parties constructing said waterway so to do, to make and maintain a suitable culvert. Notice, in writing, to make such opening and to construct such culvert may be served on such company, as provided in the service of summons, at least thirty (30) days before such railroad shall become liable; in case such railroad company shall refuse or neglect to comply with the provisions of this section, it shall be liable to pay a penalty of ten ($10) dollars for each day's refusal or neglect to make such opening and construct such culvert. The county attorney of the county in which such railroad company shall have refused or neglected to comply with the provisions of this section, shall, upon complaint being made by the party or parties interested, collect such penalty, and it shall be his duty to prosecute the same to a final determination in any court having competent jurisdiction.

SEC. 8. Any person or persons who shall willfully open, close, change or interfere with any head gates, water boxes, pipes or any other appliances for controlling or utilizing water shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than ten ($10) dollars nor more than one hundred ($100) dollars, and may be imprisoned in the county jail not exceeding ninety (90) days.

SEC. 9. It shall be the duty of the proprietor or proprietors of artesian wells constructed under the provisions of this act, to keep all ditches and waterways in good repair at all seasons of the year, and for the purpose of making the necessary repairs they shall have the right to enter upon the lands where such ditches or waterways are located along the line thereof, taking care that no unnecessary damage be done; and whatever actual damage may be done shall be paid to the owner of said lands; *Provided*, That whenever said ditches or waterways have been injured or put out of order by the acts of any person, or by the animals or stock of such person, it shall be his duty to repair the same at his own expense, and no compensation for damages shall be recovered by such owner.

SEC. 10. Whenever waterways or ditches are located or constructed along any public highway, the water which may be flowing therein shall be for the use of the public; *Provided*, That when any owner or occupant of lands adjoining or lying along such highway desires to use any portion of the water flowing in such waterways or ditch, he shall make application to the proprietor or proprietors of said artesian well, for the use of said water, and the adjustment of the amount of rental to be paid to said proprietor or proprietors for the use of the same and the terms and conditions therefor.

SEC. 11. When any waterway or ditch must necessarily be constructed across any of the school lands of the state, except in the highway along the same, permission to construct the same may be obtained from the "county board of appraisal of the common school lands," upon an application in writing, duly verified, showing the location and character of such lands, together with a proper plat showing the location of the proposed route across the same, and the permission may be granted under such conditions as shall be prescribed by them, with the approval of the Board of University and School Lands.

SEC. 12. Whereas, it is important for the best interests of this state that the system of irrigation provided for in this act should be set in motion at once, to promote the raising of crops during the coming season, it is hereby declared that an emergency exists, and that this act shall be in full force and effect from and after its passage and approval.

Approved March 6, 1891.

CREATING THE OFFICE OF THE SUPERINTENDENT OF IRRIGATION AND FORESTRY.

[H. B. No. 224.]

An Act Entitled "An Act Creating the Office of State Superintendent of Irrigation and Forestry, and Prescribing the Duties Thereof."

Be it Enacted by the Legislative Assembly of the State of North Dakota:

SECTION 1. CREATION OF OFFICE.—That the office of State Superintendent of Irrigation and Forestry is hereby created, and an officer to be known as the State Superintendent of Irrigation and Forestry shall be appointed by the Governor, by and with the advice and consent of the Senate.

SEC. 2. TERM OF OFFICE.—The first term of said office of State Superintendent of Irrigation and Forestry shall expire on the 1st day of March, A. D. 1893. The term of office thereafter shall be two years.

SEC. 3. QUALIFICATION.—The State Superintendent of Irrigation and Forestry shall, before entering on the duties of his office, take and subscribe to an oath to support the Constitution of the United States and that of this State, and that he will faithfully discharge the duties of his office according to the best of his ability. Said oath shall be deposited in the office of the Secretary of State.

SEC. 4. SALARY.—The State Superintendent of Irrigation and Forestry shall receive for his services a salary of one thousand dollars per year, and five hundred dollars per year for traveling and other expenses.

SEC. 5. POWERS AND DUTIES.—The State Superintendent of Irrigation and Forestry shall have charge of the development of a system of irrigation within the State by means of artesian wells, dams, reservoirs, storage works, canals, or other methods that may be found practical or may be adopted by the State or the people; shall have jurisdiction over the system or department of State forestry, and shall clearly explain its necessity and economic uses, and by desirable methods aid in promoting tree culture in this State; shall superintend all meteorological or weather stations or schools, and shall render such assistance as shall conduce to their usefulness. And he shall investigate and explain all the laws, causes and operations of rain falls and, as far as possible, show how they can be increased or produced by scientific methods or inventive skill; and he shall present the best systems for obviating, as far as it can be done, all unfavorable or dangerous climatic disturbances. He shall visit such parts of the State as he shall deem necessary, or as the Governor may direct him to visit, and examine and make notes of the geological formation, topography, water supply, its extent, pressure, operations and utility, and other features bearing upon artesian wells, and all other methods of irrigation and water supply from all attainable sources, and shall investigate the workings and gather all statistical information in relation to tree culture and meterological observations and experiments. And he shall recommend the Legislative Assembly, at its next session, the enactment of such measures as he may deem necessary to develop and make practical the systems, beneficial to agriculture and the people, coming under his jurisdiction.

SEC. 6. CO-OPERATION.—It shall be the duty of the State Superintendent of Irrigation and Forestry to co-operate with the officers of the Government of the United States in any survey or other work designed to establish a system of irrigation, or to solve the irrigation problems peculiar to the State of North Dakota.

SEC. 7. EXPERIMENTAL AND OBSERVATION STATIONS.—The State Superintendent of Irrigation and Forestry shall, as soon as practicable, establish each by itself, irrigation and meteorological experimental and observation stations wherever the same may be beneficial, but only where the service of practical farmers or other persons can be secured without expense to the State. The observers appointed under this section shall note carefully the time and manner of applying water artificially to the soil, and its effect on vegetation, and they shall collect such other data as may be beneficial in solving the problem of irrigation, and shall give all possible meteorological data and facts, and shall make reports of the same to the State Superintendent of Irrigation and Forestry under such rules as the said Superintendent may prescribe.

SEC. 8. ANALYSES.—It shall be the duty of the State Superintendent of Irrigation and Forestry to procure an analyses of soil and water of different sections of the State. The president of the Agricultural College at Fargo shall co-operate with and assist the said Superintendent in the work of analyses, to the end that the adaptability of the water to the soil may be determined.

SEC. 9. ANNUAL REPORT.—It shall be the duty of the State Superintendent of Irrigation and Forestry to report annually to the Governor on the 1st day of December, giving a detailed account of the work performed by him during the year, with his recommendation of such legislation as he may think needful, bearing upon the subjects involved in his department.

SEC. 10. EMERGENCY.—Whereas, as an emergency exists in that there is no law regulating the matters involved in this act, and as the best interests of the State demand their prompt application, therefore this act shall be in force immediately from and after its passage and approval.

Approved March 7, 1891.

This same day, March 7, 1891, the writer was appointed by the Executive, Hon. A. H. Burke, to the office of State Superintendent of Irrigation and Forestry.

TO PROMOTE IRRIGATION.

[H. B. No. 240.]

An Act to Promote Irrigation.

Be it Enacted by the Legislative Assembly of the State of North Dakota:

SECTION 1. Whenever the owners of any body of lands susceptible of one mode of irrigation desire to irrigate the same, they may present to the board of county commissioners of the county in which the lands, or a greater portion thereof, are situated, at a regular or special meeting of the board, a petition setting forth that they desire to adopt measures to irrigate the same, the description of the lands by legal subdivisions, the number of acres in the whole district and the number of acres in each tract, with the names of the owners thereof and the names of three persons who may desire to serve as trustees for the first three months, and the name desired for the proposed irrigation district.

SEC. 2. The petition must be verified by the affidavit of one of the petitioners, and must be published for at least two (2) weeks next preceding the hearing thereof, in some newspaper published in the county in which the lands are situated, or if there is no newspaper published in the county, then it must be published in some newspaper having a general circulation in the county, and an affidavit of publication must be filed with such petition.

SEC. 3. When a district is situated partly in different counties, the trustees must, after the petition has been granted, forward a copy thereof to the clerk of the board of county commissioners of each of the counties in which any portion of the district may lie, and the board to which the same is forwarded must not allow another district to be formed within such district, unless with the consent of the trustees thereof.

SEC. 4. If the board of county commissioners find, upon the hearing of the petition, that the statements are correct and that no land is improperly included or excepted from the district, they must note their approval on the petition, which approval must be signed by the president and attested by the county auditor, as the case may be, and from and after the approval the district shall be considered to be duly formed, and the persons named in the petition shall be the trustees for the first three months and until after their successors are appointed.

SEC. 5. The petition must then be recorded by the register of deeds in a book kept for the purpose.

SEC. 6. After the approval of the petition, the petitioners may make such by-laws as they may deem necessary, for future appointment of trustees and to effect the work of irrigation, keep the same in repair and operation, and for the control and management thereof, by the votes of consent of a majority of the owners of the lands within their district.

SEC. 7. The by-laws adopted must be signed by persons owning a majority of the lands within the district, and must be recorded by the register of deeds in the same book and immediately following the petition.

SEC. 8. The board thus formed shall have power to elect one of their number president thereof, and to employ engineers to survey, plan, locate and estimate the cost of the works necessary for the irrigation, including dams, canals, sluices, water gates, embankments and materials for construction, and to construct, maintain and keep in repair all works necessary to the object in view.

SEC. 9. The board of trustees must report to the board of county commissioners of the county, or if the district is in more than one county, then to the board of county commissioners of each county in which the district is situated, the plan of the work and estimates of the costs, together with estimates of the incidental expenses of superintendence, repairs, etc.

SEC. 10. The board by which the district was formed must appoint three commissioners, disinterested persons, resident in the county in which the district or some portion thereof is situated, and must view and assess upon the lands situated in the district a charge proportionate to the whole expense and to the benefits which will result from such works, which charge must be collected and paid into the county treasury as hereinafter provided, and must be placed by the treasurer to the credit of the district, and paid out for the work of irrigation upon the warrants of the trustees, approved by the board of county commissioners of the county.

SEC. 11. The warrants drawn by the trustees must, after they are approved by the board of county commissioners, be presented to the treasurer of the county, and, if they are not paid on presentation, like indorsement must be made thereon, and they must be registered in like manner as county warrants.

SEC. 12. If a district is situated partly in different counties the charge must be paid into the treasury of the county in which the particular tract may be situated.

SEC. 13. If the original assessment is insufficient to provide for the complete irrigation of the lands of the district, or if further assessments are from time to time required for the protection, maintenance and repair of the works, the trustees must present to the board of county commissioners in which the district was formed a statement of the work to be done and its estimated cost, and the board must make an order directing the commissioners who made the original assessment, or other commissioners to be named in such order to assess the amount of such estimated cost as a charge upon the lands within the district, which assessment must be made and collected in the same manner as the original assessment.

SEC. 14. The commissioners appointed by the board of county commissioners shall make a list of the charges against each tract of land.

SEC. 15. The list must contain:

1. A description by legal subdivisions or natural boundaries of each tract assessed.
2. The number of acres in each tract.
3. Names of the owners of each tract, if known, and if unknown, that fact.
4. The amount of the charge assessed against each tract.

SEC. 16. The list so made must be filed with the county treasurer of the county, or if the district is partially situated in different counties, then the original list must be filed in the county first in order under alphabetical arrangement, and copies thereof, certified by the commissioners, must be filed with the treasurer of each of the other counties.

SEC. 17. From and after the filing of the list, or certified copy thereof, the charges assessed upon any tract of land within the county constitutes a lien thereon.

SEC. 18. The list thus prepared must remain in the office of the treasurer for thirty days, or longer if ordered by the board of trustees, and during the time they so remain any person may pay the amount of the charge against any tract to the treasurer, without cost.

SEC. 19. If at the end of thirty days, or of the longer time fixed by the trustees, all of the charges have not been paid, the treasurer must return the list to the states attorney, who must at once proceed by civil action to collect such charges.

SEC. 20. The work must be executed under the direction and in the manner prescribed by the board of trustees.

SEC. 21. The board must accurately keep all accounts of expenditures, which accounts, and all contracts made by them, shall be open to the inspection of the board of county commissioners and every person interested.

SEC. 22. The trustees may acquire by purchase all property necessary to carry out and maintain the system of irrigation provided for.

SEC. 23. The trustees may acquire by condemnation:

1. The right to use of any running water not already used for culinary or domestic purposes, or for irrigating, milling or mining purposes.

2. The right of way for canals, drains or embankments, and other work necessary, and may take materials for the construction, maintenance and repair thereof, from lands outside of as well as within the limits of the district.

SEC. 24. The provisions of Section 3,000 Compiled Laws, are applicable to, and the condemnation herein provided for must be made thereunder.

SEC. 25. Whenever any district susceptible of one mode of irrigation is entirely owned by parties who desire to irrigate the same and to manage the irrigation without the intervention of trustees or the establishment of by-laws, they may file the petitions provided for in Sections 1 and 2, and must state therein that they intend to undertake the irrigation on their own responsibility.

SEC. 26. If the petition is granted, the owners of the land shall have all the rights, immunities and privileges granted to boards of trustees, and in all proceedings the names of the owners may be used instead of the names of trustees.

SEC. 27. All acts or parts of acts in conflict herewith are hereby repealed.

Approved March 7, 1891.

ARTESIAN WELLS.

[H. B. No. 118.]

An Act to Enable Civil Townships to Issue Bonds for the Purpose of Sinking Artesian Wells, and to Provide for Locating the Same.

Be it Enacted by the Legislative Assembly of the State of North Dakota:

SECTION 1. That at any annual or special town meeting in any regularly organized township in this State, the question of bonding said township for the purpose of sinking one or more artesian wells, or of improving natural springs in said townships, may be submitted to the vote of the people; *Provided,* The notices posted by the Town Clerk, as required by law, contain a notice of such proposed bonding.

SEC. 2. When three-fourths of the legal voters voting at such town meeting as described in Section 1 of this act shall vote in favor of bonding, it shall be the duty of the town board of supervisors to forthwith issue the bonds of said township in the denomination or denominations which they shall deem best, but which shall not aggregate more than a given amount specified by vote at the aforesaid town meeting. The concurrence of a majority of the township board of supervisors shall be sufficient to legalize the issuing of township bonds under this act. All bonds issued under this act shall bear interest at the rate of seven (7) per cent. per annum, payable semi-annually; the bonds and the interest thereon to be paid at such place and times as the township board may designate; *Provided, however,* That said bonds shall be payable in not less than five nor more than ten years.

SEC. 3. Said bonds shall be signed by the chairman of the board of township supervisors, and attested by the clerk of said township; said bonds shall also be verified by both chairman and clerk that the bonds are issued in accordance with the provisions of this act, and are within the debt limit.

SEC. 4. It shall be the duty of the township board to receive sealed bids for the purchase of said bonds, after having given thirty days notice in such manner as they may deem best; said bonds shall be sold to the highest bidder for cash, and shall not be sold for less than their par value: *Provided,* That the township board of supervisors shall have authority to reject all bids and postpone the sale of said bonds for a time not to exceed ten days.

SEC. 5. The proceeds arising from the sale of said bonds shall be paid by the purchaser thereof to the treasurer of said township, or to his authorized agent upon the delivery of said bonds; and such proceeds shall be paid out only on the order of the township board. The treasurer of any township board may be required to give additional bonds, with sureties to be approved by the board of township supervisors, before or after the proceeds of said bonds are turned over to him.

SEC. 6. Said board of township supervisors shall levy a tax at the time and in the manner that other taxes are levied, sufficient to pay the interest as it falls due on the said bonds, and also a sinking fund tax sufficient to take up the bonds when they become due; neither the interest fund nor the sinking fund shall be used for any other purpose than that for which it is levied: *Provided, however,* That the sinking fund may be deposited or loaned in any safe place for the purpose of earning interest, which shall be credited to the sinking fund, and, *Provided, further,* That any balances remaining in said fund after the payment of said bonds shall be transferred to any other township fund or funds designated by the township board of supervisors.

SEC. 7. The township treasurer shall receive one per cent for handling the proceeds received from the sale of said bonds. Upon the payment of any of the said bonds or the coupons thereto attached, it shall be the duty of the township treasurer to cancel the same by writing the word "paid" across the face of the same and the date of payment. The township treasurer shall also keep a record of these bonds, showing date, maturity, amount, rate of interest, to whom and where payable; and when any interest coupon is paid, it shall be credited upon such record, giving date of payment. All moneys derived from the sale of bonds, as provided in this act, shall be kept as a separate fund and shall be expended by the township board of supervisors in making such wells as a majority of the freeholders of said township shall think desirable: *Provided*, That such portion of said fund as shall not be used in making said wells, may at the discretion of the supervisors be transferred to the sinking fund for the payment of said bonds. Before locating a well under the provisions of this act it shall be the duty of the board of supervisors to cause to be made a survey of the natural waterways of their township, and the first well shall be placed, as nearly as practicable, at the head of the longest natural waterways in said township, unless by a vote of two-thirds of the freeholders of said township it is located at some other stated point. All subsequent wells shall be located by a majority vote of the legal voters of said township.

Approved March 11, 1891.

A SCHOOL OF FORESTRY.

Our Constitution in Article 19, Section 216, makes provision by the following words for a School of Forestry, to-wit:

"Fourth. A School of Forestry, or such other institution as the Legislative Assembly may determine, at such place in one of the counties of McHenry, Ward, Bottineau or Roulette, as the electors of said counties may determine by an election for that purpose, to be held as provided by the Legislative Assembly."

The last Legislative Assembly passed a law giving the citizens of the above four counties the right to vote upon the location of said School of Forestry.

FORESTRY CULTURE.

An Act Entitled "An Act to Promote Forest Tree Culture."

Be it Enacted by the Legislative Assembly of the State of North Dakota:

SECTION 1. Every person planting one acre or more of prairie land with any kind of forest trees except black locust, and successfully growing and cultivating the same for three years, shall be entitled to receive for ten years thereafter an annual bounty of three (3) dollars for each acre so planted and cultivated, to be paid out of the State treasury; but such bounty shall not be paid any longer than such grove shall have at least 400 living trees on each acre so maintained and kept in growing condition.

SEC. 2. Every person planting such forest trees or trees suitable for hedge in rows as boundary lines along the public highways or on any other portion of this premises, which rows shall contain not less than three living trees to each rod, and who shall in other respects comply with the provisions of this act, shall annually receive a bounty at the rate of $4 for every 160 rods of each row in length.

SEC. 3. Any person wishing to secure the benefits of this act, shall, during the month of June next after the expiration of two years after planting such grove, row or rows of trees, and annually thereafter, file with the county auditor or clerk of the county in which the same is located, a correct plat of the land, describing the section or fraction thereof, on which such grove, row or rows have been planted or cultivated, and shall make due proof of such planting and cultivation, as well as of the title to the land, by oath of the owner and the affidavit of two householders residing in the vicinity, setting forth the facts in relation to the growth and cultivation of the grove, row or rows of trees for which such bounty is demanded. The several county auditors or clerks shall on or before the first Monday of August of each year forward to the State Auditor a certified list of all the lands and tree planting reported and verified to them in compliance with this act, with the name and postoffice address of the respective owners thereof: *Provided*, this act shall not apply to any railroad company for planting trees within 200 feet of its track for the purpose of making a snow fence, nor to any trees planted upon land held, entered and acquired under the timber culture laws of the United States; provided further that not more than $100 shall be paid annually for the trees raised on any one section of land.

SEC. 4. If the State Auditor shall find that the provisions of this act have been duly complied with, he shall issue to the several applicants entitled thereto his warrants upon the State Treasurer for the bounty so earned.

SEC. 5. All acts or parts of acts in conflict with the foregoing act are hereby repealed.

Approved February 5, 1890.

A SHORT DESCRIPTION OF NORTH DAKOTA.

Area, 74,312 square miles.

Population. Per last census, 182,719 persons.

Location. Near half way, east and west, between the Atlantic and Pacific oceans, and midway, north and south, between Hudson Bay and the Gulf of Mexico.

Geology. The geological structure of North Dakota in its general makeup is cretacious, and much of its surface formation is known as "glacial drift" or "glacial deposit." However, other rock formations are found in the State.

Altitude. Above sea level, range from 800 feet in the Red River Valley to near 2,000 feet on the high lands, the coteaux, the average being not far from 1,400 to 1,500 feet, whilst the highest mountains, such as Butte St. Paul and Bear Butte, in the Turtle mountains, are near 2,500 and 2,400 feet respectively.

Topography and Surface. The general topography is that of an extended undulating plain, interspersed here and there with hills and mountains, together with numerous rivers, streams and lakes.

Mountains and Highlands. The Pembina and the Turtle mountains, the plateau known as "Les Corteaux Des Prairie," just west of the Red River Valley, and the "Dis Corteaux du Missouri," bordering the eastern shore of the Missouri river. There are also smaller elevations in different parts of the State.

Rivers and Streams. Missouri, Yellowstone, James, Cheyenne, Red, Little Missouri, White, Knife, Hart, Cannon Ball, Grand, Big Muddy, White Earth, Painted Woods Creek, Apple Creek, Beaver Creek, Mouse, Willow, Pembina, Tongue, Park, Forest (salt), Turtle, Goose, Maple, Wild Rice and smaller streams.

Lakes. Devils Lake is the largest body of water in North Dakota. It is near fifty miles long and varies in width from a few rods to many miles. Stump Lake, Sweet Water Lake, Lake Irvine, Alice Lake (Lac Aux Marts), Rush Lake, Rose Lake, Willow Lake, and Lake Metigoshe in the Turtle mountains; the latter lake has 22 miles of shore line. And many more large and small lakes abound in all sections, especially in the central part, north and south, of the State.

Thermal and Mineral Springs are numerous, some of the most noted of which are the "Spalako" and the "Minnehaba" in the Turtle mountains.

Coal. The whole country west of the Missouri and much of it to the east is underlaid with a deposit of lignite coal, which crops out in many places in veins from six to fifteen feet in thickness. It makes excellent fuel for domestic heating and manufacturing purposes and is used extensively for these purposes.

Clays. The beds of clays are very extensive, and much of it of superior quality for brick purposes. And the same is well fitted for making fine crockery ware.

Soil. The soil of North Dakota is a drift or alluvial loam from one to four feet deep, and it contains an inexhaustible supply of the most important soil constituents, such as soluable silica, lime, potash, soda, phosphoric acid, nitrogen and vegetable humas. In color it is of a dark grayish brown or black. Its quality is of the highest grade and equal in productiveness to the soils of the Nile.

Forests. As near as can be ascertained at present, we have in North Dakota near 460,000 acres of native forest and near 40,000 acres of cultivated trees. These are located along the rivers, about the lakes on the high land. The principal bodies of timber are to be found on the Missouri river and its branches, the Red river and its feeders, at Devils lake and the Turtle mountains, and on the shores of the Cheyenne and the James rivers.

HISTORICAL.

ADVERSITY LEADS TO BETTER CONDITIONS.

Coming from the east and other countries where men bestow thought upon the causes involved in unfavorable crop conditions, the people of our commonwealth readily perceived, when confronted with the drouths of 1887-88-89, that some action was necessary to counteract the direful effect of this scourge. But some, not a few, protested against any movement to bring about a better state of things, claiming it was an "interference with the designs of Providence;" but the majority, possessing greater light and scientific knowledge, were imbued with the conviction that Providence is always gracious and munificent to those who aid nature in her effort to balance conditions whereby animals and plants, fruit and grain, are produced in abundance for human needs and blessings. Hence, though mighty the undertaking, involving the best work of will, mind and hands, scientific thought, capital and labor, our most intelligent and influential citizens, sustained by the press and encouraged by the masses, took action throughout the State to formulate some system involving a clearer knowledge of the science of meterology and a wise development of irrigation and forestry for practical ends.

THE FIRST ORGANIZED PUBLIC MOVEMENT FAVORING IRRIGATION AND FORESTRY.

Taught by adversity, incidental to three successive crop failures, the result of drouth and hot winds, I became imbued with the conviction that duty to our state and the people demanded a consecration of thought and energy looking towards the evolve_ ment of a system embracing the co-related principles of meteorology, irrigation and forestry. And hence, after long years of study of the subjects, I moved for practical results.

Taking my small capital, one dollar and seventy-five cents ($1.75), the entire income of my crop of grain from ninety acres of well cultivated land, the loss resulting from drouth and hot winds of that year, 1889, I went to Devils Lake and was instrumental in organizing, on Nov. 2, 1889, "The Ramsey County Irrigation and Forestry Meeting."

This, according to my best knowledge upon the subject, was the first organized public movement in North Dakota favoring a better understanding of meteorology, irrigation and foresty and their proper development.

The great system under consideration, which I there outlined, has since been fully endorsed and upheld by the press, the legislators and the people of our and other states.

THE RAMSEY COUNTY ASSOCIATION.

Following the work commenced at Devils Lake, aided by zealous friends of the cause, I secured the organization of "The Forestry, Meterological and Water Supply Association of Ramsey County," and, acting as the President of the same, the needful work was continued with most favorable results.

ENDORSED BY OUR LEGISLATIVE ASSEMBLY.

The petition to our Legislature and the joint memorial to Congress, which I had circulated, was presented by myself to our Legislative Assembly on February 18, 1890.

The petition and joint memorial were both signed by near 1,000 citizens of our State, including many of the most prominent men in all callings, state officials and legislators. Said petition asked that our Legislative Assembly pass a joint memorial to Congress praying for the following things, namely: Proper appropriation for the survey and the sinking of artesian wells and for building reservoirs and canals in North Dakota and other western states, and for the irrigation of such lands with waters thus derived; to make ample provision for the full development of forestry in the West; to create a national Forestry department, etc. Said memorial contained all the great factors or leading features involved in irrigation, meterology and forestry. It also encouraged the establishment of a national scientific university to teach all these principles, and all the sciences, for practical uses.

And, furthermore, Congress was asked to offer rewards for the best system for producing artificial rainfall and for the prevention of drouths, frosts, etc.

The memorial was passed by said Assembly without even one dissenting voice in either House; by the House February 21st, and the Senate February 28, 1890, and the same was laid before Congress by Hon. G. A. Pierce (Senator) and Hon. H. C. Hansbrough (Representative).

WILL DOUBTLESS BE ACCOMPLISHED.

All the objects sought for in the memorial are worthy, most desirable and practical, and the achievements of the past in the direction of discoveries, inventions and the successful control of the elements, in connection with the spirit of scientific investigation of this, our new progressive age, are prophetic of the accomplishment, in some way and through some channel of operation, of many of the things enumerated in the joint memorial.

THE FORAKI ASSOCIATION OF NORTH DAKOTA.

Is a forestry, meteorological, irrigation and scientific society. It was organized at Bismarck, N. D., Feb. 28, 1889. Its officers constitute many of the leading and most prominent men of our State. All communications should be addressed to W. W. Barrett, President, Church's Ferry, N. D.

LEADING OBJECTS OF THE ASSOCIATION.

By means of petitions, public discussions, distribution of literature, press articles, lectures and other desirable methods, to popularize an interest in forestry and irrigation in North Dakota and the arid regions of the country, and to awaken a deeper, stronger and more concentrated effort for developing the same for the best welfare of the State and the people. Also to encourage such scientific research as will tend for the betterment of the race.

AN IRRIGATION CONVENTION AT GRAND FORKS AND ELLENDALE.

Ten days after the Ramsey County irrigation and forestry meeting was held at Devils Lake there was held at Grand Forks, on Nov. 12, 1889, a large irrigation convention. Hon. L. R. Casey acted as president and W. B. Bierly as secretary. It took steps towards securing national aid for the survey and development of the artesian deposits of the Dakota basin.

The tendency of that convention, composed of many of our most intelligent citizens, was to strengthen and aid the great economic movement of irrigation.

A similar convention was also held in Ellendale, Dickey county, in September, 1890. The object sought was to secure the artesian development of the State for irrigational productions.

TAPPING THE MISSOURI WATERS.

Realizing the wisdom of utilizing the waters of the Missouri river for irrigation purposes in North Dakota, in the latter part of 1889, Hon. H. C. Hansbrough introduced a bill in Congress having for its object the preliminary survey of a route for an irrigation canal to extend from the Missouri to within 250 miles of Grand Forks. Devil's lake was to be made a great storage reservoir.

All citizens of our State cannot but feel an interest in this project, and it is to be hoped the bill may be revised and made into a law, whereby great material benefits must accrue to our commonwealth and her toiling people.

IRRIGATION AND FORESTRY SUSTAINED AS A STATE POLICY.

Since the early movement in behalf of irrigation, the interest in the question has continued. At the last Legislative Assembly, the problem was thoroughly discussed and the conclusion reached was that it, and forestry as well, should be sustained as a part of the policy of the State.

THREE DEPARTMENTS IN ONE.

In South Dakota, Colorado and numerous other states, they have a Superintendent or Engineer of Irrigation, receiving a fair state salary, whose whole duty is confined to this one question.

But our Legislative Assembly, on March 7, 1891, passed a law uniting the three kindred branches, towit: irrigation, meteorology and forestry, into one department, and as such, it is generally conceded, much valuable service has been rendered to the commonwealth and the denizens therof. If the affairs of this department are properly administered, as the years pass, the necessity, the advantages and the great economic usefulness of the same will become more and more apparent, when but few can question the importance of fostering the same by all proper means and support.

A STATE EXPERIMENTAL ARTESIAN WELL AT EDGELEY.

At the last session of the Legislative Assembly, a law was passed establishing an artesian irrigation experiment well at Edgeley, La Moure county, and the State appropriated $5,000 for the purpose. All experiments are to be under the jurisdiction of the U. S. Experiment Station, connected with the State Agricultural College. For various reasons there has been delay in the work. But land has been secured, and steps taking towards sinking the well. This is a most important undertaking, and conditions at Edgeley indicate water can be found in abundance, which if secured can be controlled for favorable results.

CONTINUED INTEREST IN IRRIGATION.

During the last two years much interest has been awakened in the question of irrigation in our own State. Numerous editorial articles have appeared in various counties urging the necessity utilizing the waters yet untouched in the great artesian deposit. of a more thorough application of the system, in the direction of covering all parts of our state, and also the manipulation and use of the waters of our 671 flowing artesian wells, together with the waters of vast amount and endless extent of our common water wells.

LARGE INQUIRY FOR INFORMATION.

This department has received many letters bearing upon the points named above. These writers sought to learn of me the best methods or the proper way to manage irrigation plants of various kinds, including the wind-mill irrigation system, and much valuable information has been imparted to all seeking light from me upon this most important question.

APPLIED IRRIGATION AT BOTTINEAU.

The principles of irrigation, in direct application, have been seen during the past season in the use of waters from creeks or streams, and from rivers.

In the summer of 1894, at Bottineau, Bottineau county, Mr. Henry Dana put in a dam on Oak creek, which has its source in the well known Metegoshe lake. This raised the water sufficiently high to enable its being carried in ditches around and high up the bluffs; thence the water flowed out upon the land, having a slight declivity. Potatoes and other vegetables were grown, giving a large increasement of crop by virtue of the use of water. Although the water was let on late in the season, the result proved most favorable, and the interest in irrigation and a belief in its perfect feasibility and profitableness has been greatly extended in the north part of our State, as a result of this successful experimentation.

There are many places in our State where the waters of our lakes and streams can be utilized economically and with practical and profitable results. Without doubt, I have good reason to believe, every county in the State has these natural facilities for irrigation. I have had long correspondence with Louis LaScelle, of LaRoy, Pembina county, who seeks to irrigate 500 acres of land in that vicinity.

IRRIGATION AT WILLOW CITY.

At Willow City, Bottineau county, there is a project on foot for the construction of a dam across Willow Creek, whereby a very great reservoir will be secured. These waters, to be derived from spring freshets, would cover an area of many miles in extent. If sufficient water can be secured, this enterprise properly managed, would enable the proprietors to irrigate very large tracts of the land in the neighborhood of that enterprising town.

AN IRRIGATION FIELD AT DUNSEITH.

At Dunseith, Rolette county, can be found a most promising field for irrigation. Back from that place, in the wood lands, are many lakes, creeks, springs, marshes and streams. One lake (Willow) has a shore line of over twelve miles, and in some parts it is twelve feet deep. These waters all feed Willow river, which leaves the Turtle mountains at Dunseith. Vast volumes of water, in the spring time especially, flow in this river. Reservoirs of any desired extent can be constructed in the mountains by damming Willow river. Great defiles of land could thus be covered, having high banks of hundreds of feet. Or a reservoir could be excavated from the earth near the foot of the mountains for the empoundment of the waters. The surface and height of the land for scores of miles, to all appearances, renders conditions most favorable for irrigation of thousands of acres of the vast sweeping level plains slanting away from the mountain heights. It is apparent that but few obstacles would be encountered to hinder the successful prosecution of the undertaking. The limit of the territory that might be irrigated would doubtless be measured by the amount of the water supply. This is true of many irrigation plants. But so long as the forests of the Turtle mountains are properly and wisely protected, and the area of the same extended as it should be, there will, without doubt, be a good supply of water at Dunseith, particularly in the spring, when the water can be empounded for use in the growing season.

THE MINNEHAHA ARTESIAN SPRING PLANT.

The Minnehaha Artesian Spring, also called the Steel Spring, is located west from Rolla near eight or ten miles, at the edge, on the southern slope of the Turtle mountains. Thus far I have failed to find so great and remarkable a spring in North Dakota. It yields 283 gallons of water *per minute*, equal to 411,840 gallons per day. It has an altitude above the distant prairie of not far from 75 to 100 feet, but there is a gradual descent of the prairie to the plain below. It forms a good-sized brook in which numerous fish abound. On the low lands it has made large lakes. The supply is perpetual. A reservoir could be constructed at a small expense near the foot hills, and these waters would thus be secured for a safe, sure and profitable irrigation system, covering the hill-sides and the adjoining prairie extended below.

In connection with this prospective irrigation plant, trees of various kinds could be successfully grown for ornamentation and practical use.

THE SPALAKO ARTESIAN SPRING PLANT.

This remarkable artesian "mineral" spring, located near Dunseith, flows 42 gallons *per minute*, one-half as much as the Devils Lake artesian well. A good fair area of land could be economically and profitably irrigated with its flowage far up the hillside, in the woodlands, of this most fascinating little gusher, scattering silver spray over its self-made rock, circling round.

THE KORANEE SPRING PLANT.

The Koranee spring is located on the John Hawfacker place, up the hillside, near Bottineau village, and its estimated flow is 30,000 gallons *per day*, though by development, it doubtless could be made to yield a much larger supply. Quite an extent of land could be easily and cheaply irrigated with the waters of this spring.

All lands in the vicinity of the Turtle mountains are admirably located as to altitude, pitch and surface for irrigation purposes, and with sufficient amount of water judiciously applied, it is perfectly safe to say the soil, dark, somewhat sandy and prolific, would yield sure and large crops each successive year.

Then why should not the Turtle mountain waters, now going to waste, be utilized in their application to the soils for the benefit of the yeoman dwelling in that fair part of our commonwealth?

THE CHURCH'S FERRY IRRIGATION PLANT.

It is a remarkable fact that it would require but a small outlay of money to convert Irvine and Alice lakes, situated near Church's Ferry, and united by a coulee, into two, or practically one, great, long, wide and deep reservoir. The gathered waters, having their source from the water-sheds of the Turtle mountains, by means of the morvouse coulee, could, under intelligent control, be made to irrigate hundreds and probably thousands of the broad, rich garden lands of Ramsey and Benson counties.

IRRIGATION IN EMMONS COUNTY.

There are excellent opportunities for irrigation in Emmons county, where the waters can be secured from the heavy flowing springs and creeks of that section.

IRRIGATION WEST OF THE MISSOURI RIVER.

I am creditably informed that there are excellent facilities for irrigation near the rivers west of, and feeders to, the Missouri river, the waters to be obtained from the same rivers.

IRRIGATION FIELDS IN ALL DIRECTIONS.

Indeed, in all directions I learn by report and personal observation, that large amounts of the surface water in the form of springs, lakes, streams and rivers of our State, from the nature of the land, its topography and altitude, etc., can be used most advantageously for irrigation purposes.

HOW CAN WATER BE ELEVATED?

How are the waters of our springs, lakes, streams, rivers and water wells to be elevated so they may be employed in the promotion of agricultural, horticultural and forestal pursuits?

With scarcely an exception, it is absolutely necessary, or wisely judicious, to have a reservoir in connection with all irrigation enterprises. The water can thus be made to perform greater duty, paying handsomely for the cost of the reservoir.

The water can be elevated by means of dams or the use of pumps operated by wind, steam, animal or human power. The wind-mill is a valuable agent in such work. It is comparatively inexpensive and can be run with but very little expense, and it is safe and reliable.

When will irrigation be more extensively applied on the home farm?

When will our people learn to make use of the waters near at hand, the flowage from springs, creeks or rivers that may be upon their own premises? There are certainly waters beneath their lands, and probably exist in vast amounts in the water strata or basins from whence we obtain our well water, or deeper down in the artesian deposits. Why not exercise true wisdom and invest some capital, brain and hand work, and utilize these waters for the certainty of profitable farming?

Such a course of action is unquestionably wiser than to continue the present uncertain profits resultant from the system (?) of "dry farming," when the rain is very unreliable, and if sent is often out of season.

SIGNIFICATION OF TERMS.

The word "rock" signifies clays, sands and gravels, as well as limestone, granite and other consolidated material.

Point of saturation signifies the rock or soil is so full of water that it will hold no more.

Phreatic waters signifies the underground waters which are or may be reached by what is termed water wells or other subground works.

Underflow is generally used to signify all underground water except that of an artesian nature.

Artesian Water. The definition adopted by the staff of the irrigation and underflow investigation is as follows: To include all subteranean waters, which on being reached or opened from above are found to flow to a level higher than the point of contact, and from some permanent and general source rather than from a local and temporary one. All bored wells in which the water rises and all natural waters, such as springs, rising from below, are included in this definition, as artesian in character. These supplies may be divided into positive and negative, the first to include wells, the waters whereof flow above the surface of the earth, the second to embrace waters rising with force, but not flowing above.

NEED OF NEW WORDS.

Like all fellow men who study along original lines, or go with others out into the old fields of thought to discover new truths, or to enlarge the boundary of old ones, I am sorely perplexed at times for proper words with which to convey or express my thoughts. Thus I have been annoyed for many years. Frequently the thought is of such a nature that no word or words can be found in any language to convey the fullness and perfection thereof, the conception or thought being like an essence or vitality, perceived, comprehended and felt by the mind or spirit, exploring the things of nature, high, broad and deep.

Others have had similar experience, which is a sure evidence of human progress, and many of the ripest scholars of various ages and nations have built or created, as a matter of necessity and convenience, new words for the manifestation and conveyance of new ideas, or higher and broader conceptions of old ones. Thus it has been with the writer when studying the outlines of irrigation as expressed by the law creating this, the office of State Superintendent of Irrigation and Forestry, and as it—irrigation—is understood in its broadest and fullest scope by myself. Viewing with an inspirational thought the limitless range of irrigation, or the employment of moisture for cultural pursuits, and its general application in the affairs of human life, and its position in the economy of nature, I have been impressed with the absolute need of a new word or words enlarging the idea of irrigation to its legitimate and complete extent. Therefore, in order to facilitate the expression and conveyance of the broadest and fullest view or idea of irrigation, and also of irrigation and forestry in their inter-relationship, or as a system embodying the two great economic factors, I venture to create and present two new words, for the approval or disapproval of mankind.

IRRAMOT.

This word is built or made thus, to-wit:

Ir—the first syllable of *irrigation*; *ra*—the first syllable of *rain*; and *mot*, the first syllable of the Russian word *motzu*, signifying to wet.

FORRAMOT.

This new word is built or made thus, to-wit:

For the first syllable of the word *irramot* substitute the syllable *for* and we have the word for-ra-mot. (Accent on second syllable.)

SOUND OF THE LETTERS.

Ir as in irrigate, *ra* as in rain, *mot* as in motto, and *for* as in forestry.

SIGNIFICANCE OF IRRAMOT.

Irramot signifies irrigation in its circled fullness; its multitudinous ramifications and most perfect development; widest application; highest status. Illustration:

Irramot is the practical science which fully developed will bless in beneficent good the entire human race.

It signifies *all moisture* above in the sky, on, below or in the earth in the form of rain, showers, dews, snow, surface water, underflow, pheoratic or well water, artesian water, etc., its constituent parts, elemental forces, principles, laws of operation, functions, and the position it holds in the economy of nature, and the use of the same (moisture or water) by human agency through any and all arts, sciences or systems for irrigation purposes; human control or modification in any way of natural precipitation; artificial rainfall or showers and all other forms of moisture for the purpose of irrigation, or any other system having similar objects; *the human control and application of all forms of moisture* wherever or however found for the benefit of agricultural, horticultural, forestal and all other forms of plant life, together with its relationship and uses in the mineral and animal kingdom.

SIGNIFICATION OF FORRAMOT.

Forramot signifies the same as irramot and forestry in its most comprehensive and perfect sense; the correlationship and oneness, as expressed in one word, of the two (irrigation and forestry) economic factors, embracing all their principles, laws, functions and uses in the realm of nature, and their fullest and most perfect development and appreciation by human agency for the favorable results, of all kinds, which must accrue therefrom.

THE PRINCIPLES AND LAWS OF NATURE UNIFORM AND UNCHANGEABLE.

All the principles and laws of nature are uniform and unchangeable in their operation and effect, under like conditions. This divine order applies to all the elements and forces or whatever things exist in the universe. In this reliability and certainty man feels a peaceful contentment, perfect trust and happiness, knowing this is the way of the Great Ruler.

Man has discovered all the elements and forces of nature are in kinship or correlated, and for favorable results there must be a proper balance and harmony of action between the same. Thus, we learn plant and animal life is dependent upon light, heat, moisture and other things for an existence. Without the presence and use of even one of these elements—moisture—all animal and plant life would die.

FROM WHENCE CAN SUFFICIENT MOISTURE BE OBTAINED?

Where can sufficient moisture or water necessary for a certainty of large and profitable crops be most easily obtained? Shall it be made to come in form of artificial rain, or an increasement of natural rainfall through human action? What assurance have we that this refreshing element can be evoked by any art of mind or hand, and made to appear in proper amounts and when and where needed for cultural pursuits?

MAN'S MASTERY OF THE ELEMENTS.

Man has learned to control many of the elements and to make them do his bidding. He makes the wind to move the ship, the steam to drive the car and boat, the electric fluid to light the city, cook the food, warm the home, drive the machine and pulse the thought the world around. And not content with this strange mastery, man progressing along the line where science and art hold sway, gathers the sunbeams and teaches them to paint upon the sensitive plate the picture, like truth, unerring in its perfect delineations—mysterious revelations, as of Deity, of the golden light above. And still more wonderful, the roll of yielding wax inholds the thought, the word and the tune, remaining unfaded, unchanged and unmarred through the jar and play of time for, lo, unnumbered years, to speak and preach and sing, like a soul reborn into the newness of life, unto, and teaching, bless the children of men —master power of mind's cunning art transmitting truth and love far unto the generations hence.

THESE ACHIEVEMENTS ARE PROPHETIC.

Are not these mighty achievements prophetic, pointing to the time when reliable systems of artificial rain shall be perfected, when all necessary moisture will be secured for success in the cultivation of fruit, grain, vegetables and grasses?

If the prophecy is true, let the wise and practical aid to hasten the fulfillment.

But the day of man's control of rain, as with his mastery of other elements, has not yet come, and hence with insufficient precipitation, we, as intelligent practical citizens, must needs turn our attention to the waters on and within the earth, and learn the amount and how and to what extent they can be utilized to advantage, and with a profit, in the great industries of agriculture, horticulture, forestry, etc.

THE VOLUME OF OUR WATERS IMMENSE.

The investigations made within the last few years, point to the fact that our surface water, to-wit: Our rivers, streams, lakes, coulees, etc., and our phreatic and artesian waters, are in volume and ceaseless supply, sufficient, if properly conserved, to irrigate a very large proportion of, if not the entire State.

CONDITIONS FOR IRRIGATION MOST FAVORABLE.

We have in North Dakota not only an immense supply of water, but, as a general rule, most favorable conditions for irrigation. And all our waters, surface and underground, can be used most advantageously, and be made to yield remunerative profits on the money and labor invested.

THE FAVORABLE RESULTS TO ACCRUE FROM IRRIGATION.

And what would be the legitimate consequences that would, as a sequence, result from the judicious use of our artesian and other waters, in conjunction with forestry, through proper systems of irrigation? Shall I name them, even in part?

The hot winds, superinduced by excessive heat in the southwest part of the great arid plains, passing from time to time east and northeast over the intervening states, carrying destruction on their way, would be shorn of their blighting, destructive effect; the impoverishing drouths would cease; the frosts, in their unseasonable visitations, would be deprived of their chilling, killing force; the piercing, boisterous, deadening blasts from the icy north would be subdued; man, beast, plant, home and school, city, and land would find shelter and comfort and the climate would be ameliorated and most favorably improved, toned and fitted to the wants and comfort of life. Nor is this all, yea, but a limited amount of the blessings to accrue from irrigation and its correlated factor—forestry.

The great arid empires, sandy, but rich in elemental productiveness, yet now dry and famishing for want of moisture and trees, feeling the vivifying influence of water and forests, would be clothed and adorned with verdure on hill and plain, and grain, fruit, vegetables and grasses, vast and unmeasurable in their harvestings, with flowers and vines and shrubs creating beauty in every part, and birds that echo the voice of nature and nature's God, would appear each golden harvest time to enrich, gladden and bless the intelligent sons and daugters of the favored land. And the arteries of commerce and the marts of trade, together with all professions, arts and callings of man would receive new life and vigor, mind and heart and hand be stimulated, man's better nature awakened, intelligence increased, and all members of the great human family dwelling in the new awakened land would rejoice and be glad in the *New Eden Homes* of the higher civilization, born of the wonder-working wizard-power of *irrigation* in correlation with its kindred factor, *forestry*.

THESE ADVANTAGES TO BE SHARED BY ALL NATIONS.

All these advantages and blessings would be shared by the Dakotas and the states west, south and east, and all the grand divisions of the western and eastern hemisphere, for the benefits of irrigation in correlation with forestry is restricted to no civil lines of states or nations.

ALL THESE BLESSINGS CANNOT COME IN PERFECTION.

All the benefits and blessings named above cannot come in perfection. The elements of earth and air are mighty in their operations, and discords must needs come at times, and man in his ignorance and limitations cannot master them completely at will. But notwithstanding this, the beneficent good that must accrue from irrigation in conjunction with forestry, applied under intelligent and scientific systems where needed, will be so great and mighty that no power of man can portray the same in truth's all golden light.

NOT UNWISE TO DISCUSS THE SUBJECT OF IRRIGATION.

But some claim it is unwise to discuss the question of irrigation in North Dakota, for it is not a necessity in our State. That will depend upon the construction put upon the word necessity. I, for one, never contend irrigation in our State is a necessity in order to raise crops of grain. Such a position would be an absurdity and contrary to facts, for without irrigation even in the severest drouths, like those of 1887-88-89, many millions of bushels of wheat alone have been raised each year since North Dakota has been a State.

But during seasons of drouth, there have been thousands of acres of land put into crops where not a kernel of grain has been raised, and thousands of acres have given a yield of but four to five bushels per acre. *All states of the west have suffered to a greater or less extent in the same manner.* Practical experience give overwhelming evidence that by use of irrigation all drouth, however severe, can be set at naught, and large and most profitable crops can be raised in such seasons. There can be no question upon this point. Then, as we in our State have very large quantities of water on and beneath the earth—our artesian supply comes from the largest basin of that kind upon the globe—the position uniformly assumed by myself has been, and is now, this:

IRRIGATION IS AN ADVANTAGE

in North Dakota, as in all other states, whether in dry or wet seasons. In dry drouth seasons, it will increase the yield and profit far beyond the most sanguine expectations. *But in order* *to reach the highest status of agricultural, and horticultural and forestal pursuits in North Dakota, and to secure the largest quantity, best quality, and the highest profits on the investment and labor, as is true of all states and nations of the world, then, for these desirable and common sense objects,*

IRRIGATION BECOMES AN ABSOLUTE NECESSITY.

Therefore, in order to become rich, prosperous, useful and happy, it becomes wise for all men, women and children, of all lands and all climes, to advocate and encourage irrigation, together with forestry, to result in the betterment of the race and the development and glory of the State.

THE USE OF MANURES NOT A DISCREDIT TO THE STATE.

Brought up on a New England farm, I learned many lessons in regard to agriculture. My father was a thinker, close observer, and practical, his motto being proper preparation of the land, and at the right season, good sound seed of the best quality, careful planting, sufficient and properly prepared manures and fertilizers, plenty of water, good management and good fair profits. Governed by these rules, and assisted by his faithful, dutiful sons, he was uniformly successful at farming.

FERTILIZERS NECESSARY FOR PROFITABLE RESULTS.

But some in our neighborhood believed the use of manures and plaster used on our old homestead were altogether unnecessary, a discredit to the soil and an injury to the reputation of the State of Maine! Hence the opposers, content with things "as nature gave them," ignored the fertilizers and thus sustained a loss each year when compared with my father's success of 40 to 100 per cent.

The fertilizers used by my father were not necessary to secure a yield of corn, wheat and hay. His neighbors raised these crops without such artificial beneficial elements. But they were necessary in order to obtain the best results in quantity and quality of grain, and a good profit on the money and labor put into the work.

FERTILIZERS LONG IN USE.

The same arguments used in the State of Maine against fertilizers for successful farming are used today by some in the west against irrigation for the assurance of large and remunerative crops. Fertilizers for the soil have been used for centuries and have been made practical in all civilized regions of the globe during such times, and today.

IRRIGATION LONG IN VOGUE.

Irrigation can be traced back to the remotest antiquity, and it has been employed with the most favorable results through the long connected ages on the Eastern and Western hemisphere, and today it is a mighty factor in the matter of cultural pursuits in many of the nations of the earth.

IRRIGATION NOT A DISCREDIT, BUT AN HONOR TO THE STATE.

It is no disgrace or discredit to any state or nation to use fertilizers, or water in the form of irrigation, for the best and most profitable success in agricultural and horticultural pursuits, but on the contrary, it is most creditable and commendable to any people and a high honor to any state or nation to advocate, uphold and make practical these methods of securing bountiful yields from the earth, especially in the application of moisture or water in way of irrigation, a system that can be made operative and profitable in all divisions of the globe.

IRRIGATION FULLY ENDORSED BY ALL CLASSES.

But those who oppose irrigation in North Dakota are but few, hardly a healthy minority. Probably in no state or nation of the earth has the question of irrigation—and what I say of irrigation applies equally well to the subject of forestry and its advantages—been more thoroughly analyzed and agitated than in North Dakota. The thinkers, the writers, the speakers, the pulpit, the school and the press have given their thought, their light and their scientific practical knowledge upon this all important subject. And it has been thoroughly discussed in an intelligent manner by the farmer, gardener, orchardist and the people at large, and its principles and benefits, and its necessity for the best results, have been acknowledged and advocated throughout the length and bredth of our progressive and enlightened State.

IRRIGATION AN INTEGRAL PART OF OUR STATE SERVICE.

Nor is this all: This momentus question has received the best attention of our State officers, and secured their full indorsement. And the subject has been discussed most thoroughly and wisely in every Legislative Assembly of North Dakota, since it became a State, and every concurrent resolution passed from session to session, favoring irrigation and forestry, has been sustained by that body, without even one dissenting voice in either House. And all the laws enacted by our legislators in behalf of these important measures (irrigation and forestry) have passed both branches of the Assembly by large majorities.

Thus irrigation and forestry have received the sanction and approval of our people and legislators, and as with other advanced states of the West, these economic branches of cultural pursuits have become an integral part of our State service, like that of agriculture, fish culture, etc., honorable and creditable to the State, and the people thereof. And it must be apparent that these two branches should receive that encouragement and aid from the lawmakers and the people, that their importance demand.

TWO IMPORTANT EVENTS.

Every North Dakotan desires to have at least a general history of the great economic reforms, operating along practical lines, and hence, in a few words, I refer to two events in the history of irrigation in the United States, from which may be dated a new and lasting interest in the development of the country, through this great sensible and remunerative system of cultivation.

WORK OF THE NATIONAL SENATORIAL COMMITTEE.

By order of congress a senitorial committee was sent out at a cost of $40,000 to investigate the problem of irrigation, its possibilities, benefits and necessity in the semi-arid states and territories of the West. It commenced its work Aug. 1, 1889; it traveled 14,000 miles, examined 382 witnesses and gave such an encouraging report that from that day to this a constant interest has been taken in the question.

THE IRRIGATION AND UNDERFLOW INVESTIGATION.

After the senatorial committee had made its report, congress passed a law having for its object the determination of the extent and availability for irrigation of the underflow and artesian waters embraced within the region between the 97th degree of longitude and the eastern foothills of the Rocky Mountains. The sum of $70,000 was appropriated for this investigation. The dispatch, the quality and the amount of work performed by these intelligent scientists, and the vast amount of facts concisely and well expressed, presented in their reports, together with the comprehensive and exhaustive reports of Col. Richard J. Hinton, chief of the irrigation inquiry, will always be a source of pride to every American who feels an interest in the resources and development of this nation.

A CONDENSED DESCRIPTION OF THE GREAT SEMI-ARID PLAINS—THEIR RAINFALL, THE SOURCE, TO A GREAT EXTENT, OF OUR ARTESIAN SUPPLY.

The great arid empire of America, or "the great arid plains" of the United States, are located between the 97th degree of longitude, west from Greenwich, to the 105th degree thereof, near the foothills of the Rocky mountains, and from the international boundary line on the north to the Gulf of Mexico and Mexican boundary on the south.

These great plains, thus described, embrace an area of at least 700,000 square miles. It is a high plain or plateau, or series of plateaus. This division contains no mountains proper, and but few hills, but it rises in different localities to an altitude of 2,000 to 7,000 feet above the level of the sea, its general increasement being westward or northwestward. On the eastern line the altitude runs 830 feet at the north, an average of 1,450 in the center, and from 1,100 to 400 feet on the southern part, and on the west or foot hills limit the altitude will range 2,500 in the northwest, 5,350 in the center, and about 6,000 in the southwest.

THE HYDROGRAPHIC BASINS

of these plains are but few in number but large in extent. These basins are as follows: Rivers which have their sources up in the high valleys of the main range of the Rocky mountains, to-wit: The Missouri, Yellowstone, Platte, Arkansas, the Rio Grande and the Canadian, and those rivers which have their source and courses on the plains, namely, the James and Red rivers of the Dakotas, the Loup rivers in Nebraska, the Republican and Smoky Hill, the Cimarron, the Red River, the Neuces and the Bozcs. The White river is of the plains, whilst the Cheyenne takes its rise from the Black Hills.

The area, as herein named, constitutes the whole field or territory of the late (1890-91) irrigation and underflow investigation. Within the same is what was formerly known as the "Great American Desert."

THE GEOLOGIC FORMATIONS OF THE GREAT PLAINS.

The geologic formations of the Great Plains are the tertiary and the post-tertiary. Throughout this great expanse, the strata is generally level; a dip of 5 to 10 feet to the mile is of frequent occurence, whilst dips as high as 100 to 200 feet to the mile are scarcely discovered. The beds thicken as we move north and northwest.

All the water-bearing rocks of these late formations in these regions (the Great Plains) derive their waters from the rainfall thereof, and all the phreatic waters available without deep penetrations are found in these rocks. The tertiary grit exposed readily absorbs moisture. It is estimated that at least three-fourths of the rainfall sinks into it. It may well be called the great natural reservoir. When valleys are cut into it springs appear, being the underflow of the subterranean basins. The accumulated waters of these springs make the streams and rivers of the plains.

Are not the heavy rains of these, the Great Plains, the source of much of our artesian waters?

THE TERTIARY GRIT

consists of lime and sand or clay, with coarse gravel, but firmly cemented by lime and iron, forming firm conglomerates and mortar-beds, and from its porous nature has great capacity to retain water.

The tertiary formation of the southern and western divisions of the Great Plains and the drift formations of the Dakotas are involved to a great extent in the water supply.

The gravels of the drift region of the Dakotas, like the tertiary grit, have also very great absorptive capacity of the rainfall, and these two formations or rocks, where found, are the source of the supply of all wells that do not reach into the bedrock below.

CAPACITY OF THE DEEP-SEATED ROCKS TO RETAIN MOISTURE.

Going deeper, it is learned the rocks there having similar structure, to-wit, looseness or porosity, have like capacity to hold water. Thus, *sandstones and conglomerates rank first as water holders*. Prof. Garry E. Culver has shown that the sandstones of the Dakota formation are holders of the artesian supplies of the James river basin; also of the artesian supplies at Coolidge in the valley of the Arkansas. Sandstones also constitute a large part of the jurassic beds, and they may be added to the Dakota beds as a part of the James river basin supply.

AREA AND THE QUALITY OF THE SOILS OF THE GREAT PLAINS.

Different writers vary in their estimates of the extent of the Great Plains, and also as to the amount of the different qualities of the soil. But there is an approximate agreement on these points. Col. Richard J. Hinton, special agent in charge of the irrigation and underflow investigation of 1890, has given the matter special study, and his opinion is worthy of due consideration. Presented in a condensed way, his views are as follows:

This region is bound in general outlines, as follows: It extends from the 97th degree to the coast range of California in the center, to the Cascade range on the north, and to the Rio Grande Mexican border, and Pacific shore on the south and the southwest Its present population is near 8,500,000 or a little more. The total would make an area of about 1,100 square miles. It covers two-fifths of the United States, not including Alaska. This constitutes nearly all of our remaining public lands. In fact, when we exclude Alaska, only 23,000,000 acres of the public domain (belonging to the national government) are to be found outside of this territory. About 610,000,000 acres constitutes our unoccupied public domain. Now add vacant railroad lands, Mexican grants, lands privately owned but untilled, military and Indian reservations, and we shall have an area of not far from 850,000,000 acres, which are wholly unoccupied. The other 250,000,000 acres consists of pastoral, agricultural and mining lands. On examination, we find about one quarter of this area under cultivation to some extent. We feel safe in assuming the entire area to be 1,100,000,000 acres, and all but 100,000,000 acres are unreclaimed in any sense, and the remaining 1,000,000,000 acres may be divided as follows:

	Acres.
Reclaimable by water in sight	125,000,000
Reclaimable hereafter by possible storage	75,000,000
Pastoral areas	350,000,000
Timber areas	200,000,000
A total of	750,000,000

The balance of 250,000,000 acres can be accounted for as high mountain areas, water surfaces, so-called desert sections, and other portions believed to be wholly unreclaimable.

Opinions differ widely as to some of these estimates, but the most conservative acknowledge the possibility of reclaiming to the use of man at least 100,000,000 acres of the region west of the 100th meridian, thereby insuring the reclamation of areas sufficient to make eight states as large as Indiana, while in an agricultural sense the communities that will occupy them may be far more prosperous.

TREMENDOUS AMOUNT OF WATER SUPPLIED TO THE EARTH FROM RAINFALL.

The Earth's Annual Rainfall.—About 30,000 cubic miles of rainfall annually, enough to cover the whole land surface to a uniform depth of thirty-three inches.

Precipitation at the Black Hills.—According to Prof. Garry E. Culver, the area of the Black Hills region is about 5,000 square miles and the average annual precipitation is twenty inches, and this gives 7,260,000,000 tons of water to the earth each succeeding year.

Precipitation in Nebraska.—Prof. Lewis E. Hicks, of the State University, states: "The area of the tertiary is 54,000 square miles in Nebraska alone, and the catchment area extends into the adjacent states and territory. Not less than one and one-fourth trillion cubic feet of water (rain) annually falls upon the tertiary in Nebraska.

Precipitation of the Mississippi River Basin, according to Lieutenant Maury, amounts annually to 620 cubic miles of water.

PRECIPITATION IN MINNESOTA.

Estimating the average rainfall in Minnesota at 25 inches, they have in that state in round numbers 274,725,378,027,281 gallons falling annually upon that territory.

GALLONS OF WATER FROM THE ANNUAL PRECIPITATION OF NORTH DAKOTA.

In order to more fully impress the mind with the idea of the vast amount of annual rainfall in North Dakota, the following figures are presented:

74,312	Sq. Miles in North Dakota.
640	Acres in one square mile.
2972480	
445872	
47,559,680	Sq. acres in North Dakota.
160	Sq. rods in one square acre.
2853580800	
47559680	
7,609,548,800	Sq. rods in North Dakota.
272¼	Sq. feet in one square rod.
1902387200	
15219097600	
53266841600	
15219097600	
2,071,699,660,800	Sq. feet in North Dakota.
144	Sq. inches in one sqare foot.
8286798643200	
8286798643200	
2071699660800	
298,324,751,155,200	Sq. inches in North Dakota.
18	Average annual precipitation in inches in N. D.
2386598009241600	
298324751155200	
*231) 5,369,845,520,793,600	Sq. or cubic inches water in North Dakota.
23,246,084,544,561	Gallons of water is the amount of the annual rainfall of North Dakota.

*231 cubic inches equals one gallon.

AMOUNT OF RAINFALL ABSORBED BY THE EARTH.

The usual estimate made in regard to rainfall is as follows: One-third is absorbed by the soil, one-third runs back to the sea and one-third is evaporated. But this rule varies in different sections, and the amount of absorption varies according to the condition and nature of the soil. Prof. Van Diest estimates that one-half of the rainfall in eastern Colorado and eastern New Mexico sinks into the ground. I think it is safe to estimate that at least this amount, one-half of the rainfall, is absorbed by the virgin prairies of North Dakota, and that all of three-quarters of the rainfall in the summer season is absorbed by the cultivated soil of the State.

The above calculation indicates what a marvelous quantity of water must be annually added to the underground deposits, even in this, our own State of North Dakota. This immense amount of rainfall taken in connection with the precipitations on the 700,000 square miles of the great semi-arid plains, including also that of the entire North American continent, will answer, to a full extent, the *pressing question of the source of the phreatie, or underground, and the artesian supply of water in the State of North Dakota, as well as other states of the Union.*

NATIONAL IRRIGATION INVESTIGATION IN NORTH DAKOTA.

As required by the law of this department it became my duty, arduous but most pleasant, to act in conjunction with the United States irrigation and underflow investigation as conducted in North Dakota in 1891.

My co-laborers, or investigators, consisted of Prof. Robert Hay, chief geologist, and Col. Edwin S. Nettleton, chief engineer.

Making close and minute observation, and courteously assisted by these intelligent, cultured and practical scientists, much valuable data was obtained in regard to the geological structure, the topography and the water supply of our State. etc. This, and added information gleaned since that time, enables me to impart many facts that in the nature of things cannot, I trust, but be deemed worthy of the close and thoughtful consideration of the people of our commonwealth.

OBJECTS SOUGHT.

Our investigations were along these lines: Altitude and form of the country, geological formation, surface water in way of ponds, lakes, brooks, streams, rivers, springs and the waters beneath the surface in form of water and artesian wells, their location, flowage, pressure, temperature, their availability for irrigation purposes, involving the height and slope of the land and conditions favorable or unfavorable for the undertaking.

All questions in regard to artesian deposits and artesian wells were most carefully considered, the leading object being to learn the extent and limits of the artesian basins, the volume of their water supply, their distance below the surface of the land, the strata passed through in sinking the wells then in operation, and all other matters pertinent to the investigation. These things demanding and receiving close thought and attention from the investigators, gave much valuable information and important facts some of which I herewith present:

SPRINGS AT STUMP LAKE.

Near Stump Lake, Nelson county, we found numerous springs furnishing large supplies of water for stock. The one at John Hennessy's place, at Harrisburgh, gave a flow of one barrel in five minutes, and the one at Mrs. E. J. Phillip's place, one barrel in two minutes. Both springs were found to be mineralized, and the latter gave a temperature of 58 degrees Fahrenheit. Most of the lands in this section have the the right slant for irrigation.

FLOWAGE OF THE DEVILS LAKE ARTESIAN WELL.

Measurement of the waters revealed the fact that there had been an increase in the flowage since the measurement by the survey in May, 1890, from 80 to 83 gallons per minute. The waters continue to bring up fine sand, which find lodgement in the runways. It is evident that the flowage of this well can be greatly increased by an enlargement of the lower end of the bore. The waters can be made of practical utility in the way of a motor for running machinery and without detracting from the supply to the city for fire and domestic purposes.

LARGE UNDERFLOW ON THE "WINKE HAY MEADOWS."—WATERS OF AN ARTESIAN NATURE.

These vast hay meadows are situated in Irvine, Ramsey county, near four miles northeast of Church's Ferry.

The facts obtained all went to prove in an unmistakable manner that we have beneath these lands one of the most remarkable deposits of water, generally known as the "underflow," to be found in the entire State. Other such basins exist in our State. One to the east of the Pembina mountains is of this nature, the same is true of sections near the Turtle mountains. To all appearances the entire meadows, consisting of many thousand acres, have but a short distance below their surface one vast bed of deep water that can easily be used for irrigation purposes in any dry season. The wells on the meadow are generally thirty feet deep and the water rises to within six or eight feet of the surface, while the wells on the highlands of the lake shore are usually fifty to fifty-two feet deep and the water makes its way to within fourteen feet of the top. Ole Johnson sunk a well on his land in 1890. The size was 3x3 for twenty-six feet, then a boring was made with a two-inch auger for twenty-six feet. The water rose thirty-eight feet in one hour and a half. Since that time he has watered from this well 150 to 250 head of stock daily and the supply has not been diminished. Herman Schultz's well, on the cliff of Lake

Alice, was built in a similar way, and seems equal in every respect to the Johnson well. The water of the wells are clear, pure and wholesome and come from the quicksand just below the hard pan.

These wells are artesian in character, for their waters flow to a level higher than the point of contact, and are what are called negative artesian wells, for their waters rise with force, but not above the surface of the ground.

THE WATER WELLS OF THE "ALLALALA LANDS."

Across Lake Alice and Irvine Lake, to the west from the "Winks Hay Meadows," is an extensive level bordered by higher lands to the west and north. This rich, productive section is known as the "Allalala Lands." Here and in the neighborhood similar wells are found. A characteristic well of these lands, which are located partly in Ramsey and partly in Towner counties, is found on J. W. Wood's place. Location, meadow land; size of bore or hole, two inches in diameter; depth of well, twenty-seven feet; water stands within eight feet of the surface, showing a rise of nineteen feet above the point of contact.

Mark Henderson, living in Section 31, Towner county, has a drive well, made in 1889 by sinking a common 1½-inch gas pipe a distance of ten feet, which has supplied farmers for miles around with water, and the flow is as strong today as when the pipe was first driven.

THE ARTESIAN WELL ON THE JUDGE THOMPSON PLACE.

This well is located in Towner county, Township 157, Range 67, and near the line of Sections 4 and 5. The sinking was made thus: Dug seventy feet, and then bored to a depth of 136 feet, making a total of 206 feet. At this point the water rose to within eight feet of the surface, and has never diminished from then to now. This will suggest the probability that Towner county has beneath its surface a large deposit of artesian water of a negative nature, which can be used by means of wind-mill and other power for lifting purposes, for irrigation of those extensive rich plains.

FEATURES OF THE TURTLE MOUNTAINS.

The Turtle mountains have features unlike any other section of North Dakota. Centrally located in the north part of the State, a mass of hills rising above the encircling plains from 400 to 500 feet, whilst the highest peaks are found to be 2,400 to 2,500 feet above sea level. Here are distributed the woods and forests, here are scattered the rocks, here abound the waters, and here is the coal. The trees are of much value, serving many important uses, fuel for the people, protection to the land far and near, and conservators of the waters found there in the form of springs lakes, rills, brooks and streams.

There is no part of the State of equal area where so much water is to be found. The principal reason for so much moisture can be traced to the presence of the trees, that block and hold the snow of winter, and prevent or retard evaporation in summer.

FISH IN THE WATERS OF THE TURTLE MOUNTAINS.

It is worthy of mention that most of the waters of the Turtle mountains contain fish of good size—pickerel, suckers, etc., which furnish much cheap and nutricious food to the settlers in that section.

Numerous springs of the mountains contain valuable medicinal qualities. And it is well to remember that a number of *artesian springs* flow from these hills. I will here name two:

THE SPALAKO ARTESIAN SPRING,

often called the "Mineral Spring," is located in the mountains, near three to four miles from Dunseith. Its outlet is on the hillside, at the bottom of which flows Mineral creek, a branch of Willow river. Its flowage is forty-two gallons of water per minute. The water is pure, wholesome and not unpleasant to the taste.

This most remarkable spring has flowed through numberless ages. This we know, for it has made its yearly record, nature's historian, whose works may be read by the geologist and the scientist. The rim of the spring is in the form of a circle, but being hemmed in by the hill on one side, the water discharges over it about two-thirds of the circle. This circle embankment has been made by trees and bushes growing where the waters flowed over the rim. The diameter of the circle, which is most attractive in its formation, being not far from 60 to 100 or more feet, and the enclosure is covered with rank grass or reeds, except where the spring makes its appearance through an opening about twenty to twenty-five inches across. At this time the water passes through a sluice cut in the rim by some man. Before that it fell in sheets—sparkling silver flashes in the sunlight of time's unnumbered years—over the outer rim. On its way down the hill from year to year it has made a deposit of the minerals, held in solution or carried as sediments by the moving fluid. Thus a mass of solid, compact rock mineralized of a dark color has been formed around the spring in a semi-circle, up the hillside. This rock is one mass, broken, however, to some extent in one place by the gushing waters of Mineral creek. This rock, measured at its base, must be near 200 feet or more, and its depth near forty to fifty feet. It is one of the most attractive springs in the West, and all tourists and visitors of the mountains consider their trips unfinished until it is seen.

The waters of the Spalako spring can be successfully used for irrigation purposes.

THE MINNEHABA ARTESIAN SPRING.

This spring is located in the foot hills of the Turtle mountains on the southern border between Rolla and Dunseith. The outlet is in a narrow valley between high sloping hills, at the base of which are found a few trees and undergrowth. The diameter of the channel, where the water issues from the ground, is about that of a kerosene barrel. Its discharge is *283 gallons per minute*, and in order to form some idea of its force, when on the underflow and irrigation survey with Messrs. Hay and Nettleton, in August, 1891, I plunged a twelve-foot rail its entire length into the water within the earth, and releasing my hold, it was thrown by the power of the pressing water high in the air, and to a distance of ten to fifteen feet from the orifice. The water is clear, pure and pleasant to the taste. It has formed extensive beds of tufa at the opening and along its flow. It makes a small stream or brook, which meanders through the valley or gorge and out through the prairie, which is level, except, however, it has quite a descent, so much so that the water leaps and jumps and foams in musical play along its gravelly channel. And in the low lands of a distant valley it forms large, never failing lakes of water.

It has been dammed near two hundred rods from the output, and the water of the pond supplies vast numbers of sheep and cattle, herded on the "Steel Ranch," where the spring is located.

Many *artesian springs* are found in the West, but this is one of the most remarkable and attractive. Its location is admirable; just at the edge of the renowned "Picture Park," up in the high altitude of "the glacial wilds of the West," and easy of access to every one.

Its discharge is great, more than many of the artesian wells of the West, being 411,840 gallons per day. Every drop of this water can be utilized at small expense for the successful irrigation of the extensive valleys adjacent to the mountains.

FISH ABOUND IN THESE WATERS.

Fish abound in the waters flowing from the Minnehaha Spring, being seen sporting not far from the output.

CONDITIONS MOST FAVORABLE FOR A FISH HATCHERY.

The favorable location, the volume and the quality of the water seem to indicate most clearly that these waters could be used to good advantage for a fish hatchery.

SOURCE OF SUPPLY.

The evidence is strong that, without doubt, the source of supply of this wonderful spring must be deep within the earth, and great. And good reasons can be adduced to prove it is one of the direct outlets of waters flowing underground from Montana and other parts of the West and perhaps from the five hundred and forty millions of gallons of water that is daily furnished by the Missouri River at Great Falls, Montana, to feed, according to the direct testimony of the irrigation and underflow scientific investigators, the Great Dakota Artesian Basin.

WORTHY OF STATE PRIDE.

Our commonwealth can boast of many springs, many of remarkable characteristics and large flowage, but the Minnehaba Spring, the Gushing Giant of the Picture Park, is one in which our people at large can take much pleasure. Its location, accessibility, environments and great unceasing flow, continued through the unwritten ages of time's unbroken flight, gives it a charm, an attraction and a value that should, and without doubt will, become the pride of our great advanced State.

ARTESIAN WATERS EXIST BENEATH THE TURTLE MOUNTAINS.

The discovery made in connection with Turtle Mountains in the direction of artesian deposits is of great value. In 1891, the United States Underflow and Irrigation Survey, under the direction of Messrs. Hay and Nettleton, chief geologist and engineer, with whom I had the honor and pleasure of co-operating, made an investigation of the Deloraine artesian well, located in Manitoba, near the Turtle mountains. At that time it had been sunk 1,800 feet, but no water found. These gentlemen stated if a flow should be secured, it would demonstrate the existence of an artesian deposit from the southern to the northern line of North Dakota. The well has since been sunk to a greater depth and its flow has been great and continuous. This of itself is an evidence that artesian water exists beneath the Turtle mountains, and that the artesian basin extends from the northern to the southern line of our State, and the artesian springs of the mountains add new evidence to these important and gratifying facts.

THE ORIGINAL SOURCE OF THE TURTLE MOUNTAIN'S ARTESIAN WATERS.

Many evidences can be adduced tending to prove that there exists an underground current or flow eastward of artesian water, or large deposits of the same, having its source from the Missouri river at Great Falls, Montana, or other parts of the river, and other sources further west, with an outlet at the Turtle mountains. As a confirmation of this idea or supposed fact, we have the remarkable flowage of the Minnehaba and Spalako artesian springs on the south and southwest line of the mountains and the very great flow from the Delorane artesian well in Manitoba, just north and close to the same mountains.

Now if the artesian water moves eastward, as taught by the scientific investigators, and forms a basin or deposit in the north part as well as the eastern, southern and central parts of North Dakota, why could not the flow be tapped in the western part of the State, where it must pass in its eastward movement or as it mingles with the vast seat of artesian water that seemingly exists under all or the largest part of our State? If such a discovery could be made, it would harmonize with and tend to prove the theory advanced above, and this what has been done. An artesian well of large flowage has been secured at Medora, Billings county, on the Western border of the State, the waters being of good quality and used by the Northern Pacific Railroad Company for operating its engines.

In years to come additional light may be thrown upon this interesting question, to prove or disprove the theory.

This question is attracting considerable attention, for it involves much which may prove of practical value. If the artesian deposit shall be found to exist in the Northwest part of North Dakota, as in other parts, and in large quantities, then, in time, that vast area now unsettled may be brought under a high state of cultivation by the hardy pioneers who may there build their homes.

Should not experiments be made to solve this problem? As suggested in my last report, an experimental artesian well at or near Minot, Ward county, would prove of very great advantage in and of itself, and aid, if secured, in giving light upon this problem.

MORE EVIDENCE AS TO SOURCE OF THE ARTESIAN SUPPLY.

Below I present a letter from W. S. Morden, of Willow City, Bottineau county, a prominent man of a thoughtful and practical turn of mind. His statements tend to indicate the existence of other artesian springs or outlets of artesian waters in the Turtle mountains, besides the Minnehaba and Spalako springs of that nature which I have named, and also tends to prove the source of supply comes from the west.

WILLOW CITY, October 22, 1894.

HON. W. W. BARRETT,
Commissioner of Irrigation and Forestry,
CHURCH'S FERRY, N. D.

MY DEAR SIR:—I wish to draw your attention to what I think a discovery in the line of irrigation, namely the underflow between the Rocky mountains and Turtle mountains.

In the summer of 1889 we cut hay on a meadow in Willow river bottom, adjacent to the national line on the Dakota side, which was dry during the fall and winter in the summer of 1890. We allowed Mr. Rice to occupy our rights, such as we had, to cut the same meadow, which he did in the month of July. In the month of September he went to look after his stacks and found them standing in about 15 inches of water, and no visible cause, as we had not had any rain; that was one of our dry years, so much so that we had a total failure of crop. During the month of July I went to Puget Sound. On my way I had occasion to stop over between the two summits, that of the Rockies and that of the Cascades, and in making inquiry at Horse Plains, was told that in March of 1890 they had a snow fall to the extent of several feet, which was carried off by rain, filling lakes and rivers which had been dry for several years, and the settlers were cutting hay to the extent of 1½ tons per acre. Said land had not afforded sufficient grass for grazing for several years.

On reaching home I found the Springs of Turtle mountain had burst forth in such volume that they had filled the lakes and caused Willow river to flow during the remainder of the fall months.

The water came down with a rush of about 20 inches depth. There not having been any rain, I attribute the flow to an *underflow*, which I would very much like tested in the interest of irrigation, believing if the same be correct, and discovered, would be a great boon to the State and people.

Respectfully yours,
W. S. MORDEN.
(Ex-County Commissioner of Bottineau County.)

SHALLOW UNDERFLOW DEPOSITS.—A REMARKABLE ONE IN EDDY COUNTY.

In many parts of North Dakota there exist shallow underflow deposits, where on investigation the water is found near the surface. Such a deposit is to be found not far from Tiffany, Eddy county, covering an area of near ten or twelve miles square. The soil consists of a sandy loam, underlaid by a thin subsoil of clay, which is not over one foot thick. Under this is found sand, fine grained, loose and clean. Making excavations from four to five feet, water is found in the sand that seems almost inexhaustible. But in some places excavations must be made from seven to twelve feet before water can be secured. A most desirable section for irrigation by use of windmill power.

LARGE UNDERFLOW AT WILLOW CITY.

Another remarkable shallow underflow exists at Willow City, Bottineau county. I have been creditably informed this deposit extends for many miles, reaching to the Mouse river and contains many thousand acres.

The water is found at a depth of from eight to twelve or sometimes fifteen feet, and the supply is so great that it seem practically inexhaustible. This water is pure and healthy. This great and extensive deposit, being so near the surface and attainable with but a very small expense, by use of the windmill irrigation system, can be utilized to the best advantage in the direction of the great industries of the county, agriculture and horticulture. Large profits can unquestionably be secured on the money and labor employed, where this underflow shall furnish sufficient water for the wants of the crops. The contour of the land, and its nature and rich, productive quality, being a sandy loam, would, with the judicious use of water, produce the largest crops of the best quality.

If the farmers of that section would utilize this moisture, which nature has placed just below their feet, it would increase their profits from 100 to 500 or more per cent.

A windmill with a wheel 10 to 12 feet in diameter would lift sufficient water, which, used in connection with a reservoir—*which is an indispensable, though inexpensive, adjunct of all irrigation windmill plants*—would enable the farmer to cultivate near 10 to 12 acres.

In one county in Kansas, Finney, wherein is located Garden City, 125 irrigation windmill pumps are in operation, and the uniform testimony of the owners is this: They are a success in every way; the crops are certain and the profits great. The underflow deposits at that place seem similar to those at Willow City and in Eddy county. Water is there reached at a depth of 12 to 15 feet.

Altitude of some places in North Dakota—

	Feet.
Church's Ferry	1,458
Willow City	1,471
Towner	1,481
Cando	1,486
Barton	1,505
Rugby	1,561
Minot	1,562
Bisby	1,606
Bottineau	1,638
Perth	1,731
Rolla	1,818
St. John	1,945

Lake Metigoshe, or Fish Lake, is 480 feet above the level of the village of Bottineau, making it 2,118 feet above the level of the ocean.

DEVILS LAKE DRYING UP.

On arrival at Bartlett, in April, 1883, I commenced to haul lumber to Devils Lake, a distance of 25 miles, for the first buildings of that city. Unloading my lumber for the Lakeview hotel, I commenced at once to make observations, or to "spy out the land." My first act was to examine Devils lake in order to learn its height, etc., and my second step was to dig up some trees on its shore for replanting on my selected claim, now known as the "Sylvatan ranch," in Ramsey county.

I made a thorough inspection of the various beaches of the lake, and there, guided by the teachings of geology, I read the work of the ages. The benches, most clearly defined, demonstrated the fact that in the years long past that lake contained a *very much larger amount* of water than what it did at that time—April, 1883,—suggesting two things: either larger precipitation in ancient times, or the presence of vast forests at that remote period on the adjoining plains and the regions far away to the north. Both of these features or conditions doubtless existed in those old ages of immense surface water.

Soon after my first visit to Devils Lake, Captain E. E. Heerman, the veteran of the "inland sea," built the steamboat known as the Minnie H., and made daily trips, as now, across the waters from its pier in Teller bay. For a number of years that pier has stood high on dry land, and now all water has disappeared from the bay and the lake continues to dry up. On account of non-supply, except in limited quantities, and evaporation, and, perchance, to some extent, to seepage, the water of Devils lake has fallen or been lowered in volume to the extent of eight to ten or more feet since 1883, and investigations go to prove the lake is now 14 or more feet lower than when Fort Totten was first established.

Unless this lake can be replenished from some source, in time it, without doubt, will become dry, which would prove a direful calamity to those dwelling upon its shores and the State at large.

BY WHAT SYSTEM CAN DEVILS LAKE BE REFILLED?

By what means can this historical and renowned bay of water be refilled? This can be accomplished by means of a great canal conducting the waters of the Missouri, or the Mouse river, into the lake, which should be made a great reservoir for the empoundment of irrigation waters and the propagation of fish needed by our people.

But there is another system that can be adopted that would prove successful to a high degree, and also add materially to the benefit of the State in other respects. And that system or plan is this:—To the north of Devils lake is a great water shed of which it is the center. Included in this territory are parts of Ramsey, and all or parts of Towner, Rolette, Pierce and Benson counties. The natural drainage of this area, in form of surface water (coulees and streams) and the underflow, is towards Devils lake. The altitudes of places as given in the preceding article go to prove this fact.

NEW SPRINGS AND COULEES WOULD BE CREATED FOR FAVORABLE RESULTS.

Now let these lands named above be covered with trees, groves and forests to the extent of at least one-quarter of the area, and in addition let the woods of the Turtle mountains be properly protected from fires and unnecessary destruction by the axe, and increased by proper tillage, then, when this shall be accomplished, the snows of winter and the rains of summer will be conserved, evaporation retarded, moisture furnished to these lands, and crops increased, so the less land cultivation would be far more remunerative than the entire treeless lands now under a state of tillage. And should this same system of forest culture be extended throughout the State, and the West, this same section, as well as the State at large, would be practically protected from the scourge of drouths and hot winds, that come periodically to impoverish the West.

And this is not all: Then it would become apparent that Devils lake would be refilled with water, for the coulees and streams, the marshes, lagoons and sloughs, and the new made springs, incidental to a wooded country, as these lands would be, would furnish a large volume of constantly inflowing water, as in ancient times, for the infilling of our North Dakota natural reservoir—Devils lake.

ONLY PRACTICAL COMMON SENSE NEEDED.

The forestation of the watershed of Devils lake would take some money, but the principal things needed would be a good stock of practical common sense, skill, judgment, labor and care, such as is needed for success in raising wheat and other cereals, fruit and stock. But the advantages counted even in dollars and cents would be far more than any lip or pen can tell.

Who in this great watershed area of Devils lake will advocate and work for the creation of these forestal developments, fraught with greatest benefit to the State and the people? They who thus work and accomplish their objects will benefit, in a large degree, themselves and their children's children, for in six to ten or fifteen years' extensive plantings and cultivations of the trees, in the area named, would result in large forest growth, for fuel, fencing, wind-breaks, favorable crop conditions and æsthetic uses.

BUT LITTLE CAPITAL REQUIRED.

To effect the forestation of the watersheds of Devils lake, the cost would be slight, and the capital required would be small on the part of each farmer in that section, and besides furnishing the means for supplying Devils lake with water, the forest, in and of themselves, would be of incalculable benefit from all points of view.

DESTRUCTION OF TIMBER CAUSES THE DRYING UP OF THE LAKES AND OTHER WATERS.

As in all parts of the world, so in North Dakota, the destruction of the woods or forests causes the drying up of the springs, lakes and streams. This is owing to the fact that the trees being removed, the once forest floor becomes dry by action of the sun and wind, and thus the supply to the depressions is removed, and the collected waters being no longer protected by the shelter and shade of the timber are steadily lowered in volume by the process of evaporation, which because of the rarity of the atmosphere is very rapid in North Dakota and throughout the entire West. Thus in time our once large, broad lakes become perfectly dry, so much so that many of them are plowed up for crop purposes.

DECREASE OF LAKE WATER IN BOTTINEAU COUNTY.

This process of natural action is exemplified in the western part of the Turtle mountains. There, in Bottineau county, the fires of recent years have destroyed hundreds and thousands of acres of timber and much of such lands have been cleared for farm purposes, and what is the result?

On these cleared lands the waters of the lakes, sloughs, brooks and streams have practically disappeared. Indeed, when I visited that section in 1892, I found a number of the lakes and coulees perfectly dry. That indicates most clearly that if the forests of the mountains should be destroyed by the fires or the axe, the great bodies of water which exist there at this time would disappear, and the lands become subject to severe drouths and loss of crops. And more than this: The great underflow in and near the mountains would diminish to a large degree, and the streams and coulees fed from such sources would become dry, except in seasons of great precipitation. And the result would extend further—the lakes, such as Lake Alice, Lake Irvine and Devils lake, would be unfed, and hence become dry, if not supplied from other sources. The waters of such lakes are decreasing each year, and one of the reasons is the disappearance of the woods of the Turtle mountains. Hence every possible consistent effort should be made to exclude fires from these mountains, to prevent unnecessary destruction of their woods, and an increasement of the same by proper care and cultivation.

THE CAUSES AND EFFECTS UNIVERSAL IN THEIR OPERATIONS.

And what is true of the loss of water in the natural channels at the Turtle mountains, and the effects of same, is equally true of all other parts of the State, the nation and the world, where the fires and the axe have destroyed the forests.

THE ECONOMIC LAW OF THE FORESTS.

And the law discovered is this:

DESTROY THE FORESTS AND THE SURFACE WATER AND UNDERFLOW DECREASE OR DISAPPEAR, INVITING DROUTHS, LOSS OF CROPS AND IMPOVERISHMENT; SUSTAIN OR CREATE THE FORESTS AND THE SURFACE WATER AND UNDERFLOW ARE MAINTAINED OR INCREASED FOR FAVORABLE CONDITIONS OPERATING AGAINST DROUTHS, AND CONDUCING TO THE INCREASE OF CROPS, AFFLUENCE AND HAPPINESS.

LARGE AMOUNT OF SURFACE WATER IN '83.

Before settling in North Dakota in 1883, I had lived in numerous Western states, and frequently visited in my line of business, railroading and commercial work, every Northern state from the Atlantic to the Rocky mountains, and many of the Southern states, to the Gulf of Mexico. And though I was a close observer, I never saw, in all my travels, one-tenth as much surface water in any one state as I found in North Dakota in that year (1883). All the streams, coulees, creeks, lakes and sloughs were full, and as there are numerous depressions upon the plains, water was seen afar, and near, and around. I know men, who, desiring to avoid the water, found it difficult to lay out a farm of dry land. This was true of my own experience. On a train from Grand Forks to Bartlett, the then termination of the now Great Northern railway, I heard an intelligent man say: "Well, North Dakota has superb soil, but it will always be a land of small farms, because the surface water will not permit the practical cultivation of large ones." Behold the change! The waters of the Red river bottoms have dried up, our sloughs are empty, the coulees are dry, many of our lakes have given room for farms upon their rich bottoms, whilst the larger lakes and rivers hold but little water, compared with the amount they contained in the eighties. What has wrought this change? This is an important question, for it deals with operative causes directly affecting our water supply. Can the decrease of water be traced to drouths? Has the rainfall lessened? Has evaporation increased? It is apparent, if we study closely, we will discover the operation of numerous causes, more or less related.

LARGER AREAS OF WOODS.

At the time of the early settlement of our State a much larger quantity of natural forest or woods abounded in and adjacent to our State than at the present time. These held, as natural reservoirs, beneath the litter of the forest floor, the melted snow, surplus spring freshets and the rainfall, and blanketed by the leaves, held by the root-mats and shaded by the trees, the evaporation was held in check, and thus a supply of moisture was kept in store to water the land. But the protection being removed by the destruction of much timber needed by the settlers, and by the ravishes of the fires, the water disappeared.

MORE CAUSES.

But the disappearance of our surface water cannot be traced wholly but only in part to the destruction of our woods by the axe and the fires. Our pioneers came to North Dakota to make a living at farming. They broke the virgin sod to evaporation, opened the capillaries of the soil, admitted the sun and heat, and under the movement of our rapacious winds the escape of the moisture became rapid. The crops absorbed the waters, and the loosened earth, through greater infiltration and attraction of the separate particles, took unto itself three-quarters of the rain that formerly flowed off over the hard vegetable shield to the various depressions of the land.

Thus four great operative causes have brought us to something like a water famine, to-wit: The decrease of our woods, the breaking of the land, conducive to increased evaporation, the water consumed from year to year by the grains, grasses and vegetables, and what seems the chief cause, the absorption of vast amounts of moisture by the cultivated soil.

THESE FOUR CAUSES WILL ALWAYS BE IN OPERATION.

These four causes will always be in operation in North Dakota, all tending to lessen the water supply. And what are the remedies to counteract these influences, or renew a needful supply of moisture favorable to the best climatic and crop condition? The same can be expressed in a few words:

Irrigation in its most intelligent and scientific form, as may be needful, and the proper forestation of the State, both in their legitimate effects, conducing to the increase, conservation and best use of moisture, resultant in practical benefits in many ways to the State and the people.

THE GIANT ARTESIAN SPRINGS AT GREAT FALLS.

The artesian springs of the arid region or the Great Plains are deserving of special attention from this department, for their existence and operations are full of suggestive lessons, but the limit of this work prevents a complete presentation of the subject.

These springs are found in the valleys of the Missouri, Big Sioux, James and the Vermillion rivers, at the Turtle mountains, and in other sections, amongst which may be mentioned the group of springs found at the head of the San Antonio river, a few miles out of the City of San Antonio, Tex., which gives a flowage of 23,000 gallons per minute, nearly 50,000,000 gallons per day.

The great artesian springs of Montana are located in Cascade county, one and a quarter miles northeast of the city of Great Falls, Mont., being on the south side of the Missouri. One of these, however, discharges its waters in the center of the Missouri, opposite and not far from its companion, which is called the "Great Giant Spring." The water is limpid and pure, and evidently flows from a deep source, and, in the language of Col. Edwin S. Nettleton, "must come from the subterranean channels of the Dakota rock." It is located in the Dakota group or formation, which rock covers large sections in the region near to Great Falls. O. C. Morton, one of the investigators connected with the late irrigation and underflow survey, has estimated that the waters from these two springs increased the Missouri river at that point to about one-tenth of its volume; and Col. Nettleton ascertained by test measurement, in the fall of 1891, that the flowage of these great giant springs was 638 cubic feet per second, equal to 55,123,200 cubic feet per day, or otherwise expressed, near 413,424,000 gallons every twenty-four hours.

Facts and evidences suggest to the writer the idea that these giant artesian springs and the artesian springs of the Dakotas may, and probably do, have their origin from one and the same source, and that, too, from the deep formations of the Dakota rock.

THE DISAPPEARANCE OF THE MISSOURI RIVER WATERS AT GREAT FALLS.

The Missouri river first comes in contact with the Dakota sand rock at the city of Great Falls, Montana. The whole formation seems to have, in very many ways, the same characteristics of the water-bearing rock of the James river valley artesian basin, as the same has been revealed by the logs of the many borings.

In the closing up of the irrigation and underflow investigation, in the autumn of 1891, Col. Edwin S. Nettleton, chief engineer, made a careful investigation of the Missouri river at this point (Great Falls), and discovered, by thoroughly tested measurements, that 834 cubic feet of water is lost, according to the tests, somewhere between the foot of the great falls and Fort Benton, forty miles down the river, each second of time, equal to 72,057,600 cubic feet every twenty-four hours, or defined in other words, in round numbers, the enormous volume of 540,432,000 gallons of water, that in this small spot of the West, feeds the great artesian deposit every day of the year, and every year of time.

Just below the great falls, which has a perpendicular plunge of ninety feet, ten miles down the river from the city of Great Falls, the river passes over the upturned Dakota sandstone, and here, in a distance of near twenty-five miles, it is supposed, most of the lost waters enter within, and are carried down the incline of the Dakota rock strata to the Dakotas—the James river valley basin being nearly 600 miles distant.

Large acres of the Dakota sand rock are exposed to the surface in Montana, in the vicinity of Great Falls, and it was learned by the irrigation investigation that considerable of the waters of small rivers and streams sink into the rock. Thus we discover additional sources of the supply of the Dakota artesian deposit.

Here we have a remarkable feature of the movement of water at this point. From the giant springs there comes a flow of artesian waters amounting to 413,424,000 gallons per day. These mingle with the Missouri, where the waters sink into the earth at the rate of 540,432,000 gallons per diem, and reappear, it is supposed, through the artesian springs and artesian wells of our own fair Dakotas: Surely nature gives many instructive lessons by its economic operations.

ALL UNDERGROUND WATER FROM THE RAINFALL.

Prof. Robert T. Hill states the source of all underground water is the rainfall. Therefore in order to attain to a clear conception of irrigation, especially as regards the source of the water supply, it becomes necessary to study the question of precipitation in the western regions.

THE MARVELOUS AMOUNT OF PRECIPITATION IN THE MISSISSIPPI RIVER BASIN.

According to the testimony of Lieut. Maury, the annual precipitation of the Mississippi river basin is six hundred and twenty (620) cubic miles of water. The great northwestern mountain system, through the Missouri river and its tributaries, furnishes a large portion of this immense supply. According to Maury, the amount of loss is equal to one to six (1 to 6.) The discharge in the Gulf of Mexico, he estimates to be but one hundred and seven (107) cubic miles, leaving the great volume of five hundred and thirteen (513) cubic miles to be accounted for. If we grant a loss of 170 cubic miles by evaporation, as leading scientists claim is approximately true, we have the vast amount of three hundred and forty-three (343) cubic miles—343 miles long, 343 miles wide and 343 miles high—of water as the quantity imbibed each year by the earth in the Mississippi river basin alone! And if we allow one-half of this huge volume, 171½ cubic miles, to the western portion of the drainage basin, we have a marvelous supply of water from that section, which the authorities claim finds its way into the underground waters, phreatic and artesian, of the Dakotas. It is not presumably true that this immense volume of rainfall centers wholly in our own great underground reservoirs, but the presumptive and much of the direct evidences are strong that the inflow from that source is marvelously great. Truly nature is munificent in its bounties of water, the life-fluid of the world, to our own rich progressive State.

THE RATIO OF DRAINAGE

or outflow to rainfall is given by other authorities as follows: The Missouri, upper and lower, gives at its outlets but 15 per cent. of the precipitation which falls over its drainage basin. The upper Mississippi is rated at the same figure; the Arkansas and White rivers give a similar per cent. of outflow; the Ohio river presents 34 per cent.; the Red river of the South is credited with 20 per cent. outflow; while the Yazoo gives 90 per cent. at its mouth. The Darling river in New South Wales gives but 8 per cent.; the Thames 32 per cent.; the Seine 33; the Elbe 25; the Murray, the largest river on the Australian continent, gives only 24 per cent. outflow from its total precipitation. Still another proof of the loss of precipitation and river flow by sources other than evaporation may be seen in the fact that the upper Missouri valley, from Fort Buford, Dak., to Omaha, Neb., embraces an area of 160,760 square miles. The annual average of normal rainfall in cubic miles will be 39.34, as shown by the records of eighteen years. The maximum discharge into the central Missouri valley has been estimated at twenty-seven cubic miles annually. This would leave twelve such miles to be accounted for. A comparison made in another form will give for a period of twenty-four months a mean of 22.32 inches. During the same period the observed outflow was but 4.1 inches and the computed outflow was but 5.9.

GREAT QUANTITIES OF RAINFALL.

In order to assist those who desire to obtain a knowledge of the volume of the rainfall, I give herewith a table that will prove of much value:

VOLUME OF RAINFALL PER MINUTE FOR GIVEN INCHES PER 24 HOURS.

RAINFALL.	Volume on 1 Acre.	Volume on 1 Sq. Mile.	RAINFALL.	Volume on 1 Acre.	Volume on 1 Sq. Mile.
Inches.	Cubic Ft.	Cubic Ft.	Inches.	Cubic Ft.	Cubic Ft.
.1	.252	161.33	1	2.521	1,613.31
.2	.504	322.67	2	5.042	3,226.62
.3	.756	484.01	3	7.563	4,840.00
.4	1.008	645.33	4	10.084	6,453.25
.5	1.264	806.67	5	12.605	8,066.56
.6	1.515	968.00	6	15.126	9,679.87
.7	1.765	1,122.73	7	17.647	11,293.18
.8	2.107	1,290.67	8	20.168	12,906.50
.9	2.269	1,450.00	9	22.689	14,529.81
			10	25.200	16,133.12

Four cubic inches in twenty-four hours will give 6,423.25 cubic feet to each square mile per minute. Eight inches so falling will give a volume of 12,905.50 cubic feet per square mile. To put it in another shape, one inch of rainfall will give to each square mile, or to one section of the public lands, a volume of water equal to 550,400 barrels. Estimating the average rainfall of the upper Missouri valley east of the foothills at about twenty inches per annum, we shall obtain 1,100,800 barrels of water to the square mile. It will be necessary to have for security, in the ripening period of summer, an artificial supply of water equal to about five inches of the rainfall, or 220,800 barrels to the square mile. An artesian well of the ordinary Dakota capacity will thus, if its annual supply were stored for irrigation purposes, furnish at a flow of 100 barrels of water a minute 52,560,000 barrels per year. It will require, therefore, according to Prof. Culver, upon whose authority these figures are given, but seven such wells to irrigate one township, or thirty-six square miles of land. Recalling, then, the figures of Maury and others that show the difference between precipitation and outflow over and from hydrographic areas, we may arrive at some conception of the extent of loss in percolation or evaporation of the rainfall and snow water that falls upon the mountain, foothills and plains region. Within our own arid section, unless in such limited areas as the Colorado and Mojava deserts, on the Paramint waste, or within the desolate bowl formation of Death's Valley, the evaporation seldom exceeds one-third of the fall. Certainly not over 40 per cent. of the entire precipitation therein is lost through evaporation.

THE EARTH'S GREAT POWER OF IMBIBATION.

How does the water enter the earth? By absorption directly from the air, by deposition, at night, seen in the form of dew and condensation of particles, by precipitation direct from the sky in form of rain and snow. Nor is this all, by large percolation from the surface, and by unseen channels flowing between lakes, seas and oceans, constituting subterranean streams, passage ways, or veins through which the fluid circulation of the globe is carried on.

The absorption of the rainfall in many parts of the West is very wonderfully great. This is true of North Dakota and Colorado. Engineer Van Diest gives the extent of the seepage in that state (Colorado) as equal to five cubic inches over 32,000 square miles of surface, constituting an amount equal to 754,080 cubic feet of water disappearing into the ground every minute, enough to irrigate an area of 1,200,000 acres.

CONDITIONS NECESSARY TO FORM AN ARTESIAN WELL OR BASIN.

Speaking geologically, in order to obtain an artesian basin, the following conditions are necessary, to-wit:

First—A pervious stratum to permit the entrance and passage of the water.

Second—An impervious or water tight bed below to prevent the passage of the water downward.

Third—An impervious bed above to prevent the escape of the water upwards.

AN ILLUSTRATION OF ARTESIAN BASINS.

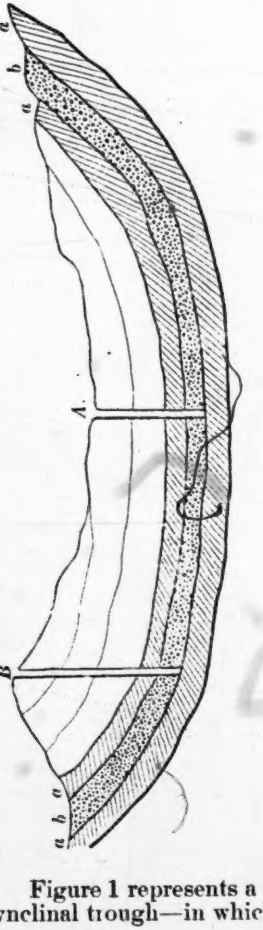


Figure I.

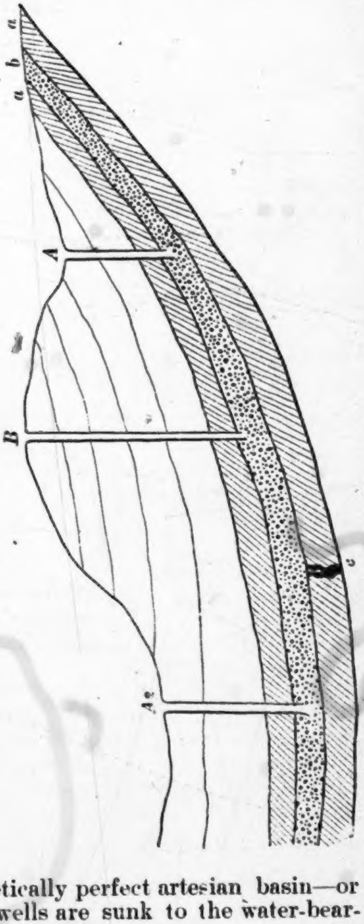


Figure II.

Figure 1 represents a theoretically perfect artesian basin—or synclinal trough—in which the wells are sunk to the water-bearing stratum, which is inclosed between two inpervious beds. The well A has flowing water, because its mouth is below the level of the outcrop of the porous stratum. The well at B does not flow at the surface, because the mouth is higher than the outcrop at the margins of the basins.

Figure II represents half a basin, or a simple monocline structure, in which artesian well may be expected, and also a breach in the lower impervious strata, which would cause a failure of artesian flow at the well situate further down the slope.

WATER WELLS.

The question of the water wells of North Dakota is one of vital importance, for the reason that the life and health of man, and the domestic animals, depend upon their nature and condition. With great advantage and profit to the State and the people, much time and careful, considerate thought could be given to this all important subject, the line of inquiry, among other things, being how the waters, if of an injurious nature, may be properly improved for use, and how, also, the wells may be kept clean, and protected from the foulness and impurities, that through ignorance or carelessness, find a lodgment therein, leading to fevers and various other diseases, lingering sickness and at times to death. Careful and stringent laws should be enacted, and properly executed, having in view the purity and healthfulness of all well waters.

The water wells of our State vary from 10 to 75 feet or more. But from knowledge obtained to date, the conclusion reached by the writer is that the average depth reached is not far from 35 feet.

The original source is the rainfall. They have their supply from the phreatic waters, also called the "underflow" or "sheet" water. Generally the waters are derived from the glacial drift, and in their natural condition are uniformly pure and healthy. Many of these are soft, and some are hard but wholesome, containing, like all well water, mineral qualities, varying in amount according to the locality or stratified conditions.

As a rule, if the wells are shallow, say from 10 to 15 feet, the water is found in layers of fine sand—often called "quick sand." Such waters are most generally very pure. If the wells are deeper, from 25 to 40 feet, the water is informly found in coarse gravel, just below the "hard pan" or clay. There the crystal fluid, wholesome and sweet, gives its vivifying nourishments from out its mystic deeps for human, animal and plant life—the wise dispensation of beneficent grace through the natural working of the natural elements.

MANY OF THE NORTH DAKOTA WELLS ARE ARTESIAN IN THEIR NATURE.

A large proportion of our water wells are of an artesian nature. This can be truthfully said, because the water rises, and often to a considerable height above the point of contact. Often the water rises suddenly, as it did in my well on my Sylvaton ranch, reaching an altitude of eighteen feet in about three minutes. Many instances of a similar nature are occurring constantly in many if not all the counties of the State, and my conclusion is that in most of these instances the waters remain practically at the original height, though lowered for a short time when used in large quantities for stock or other purposes.

VIRTUALLY INEXHAUSTIBLE.

It is safe to say, for that is reasonable, there is a limit to all earth water deposits, but the large and never-failing supply seems to demonstrate that the phreatic waters of our common wells are virtually inexhaustible, at least in many parts of the State. If this in time should prove true, these waters may be utilized for irrigation purposes, the lifting being accomplished by wind-mill or other power.

IMMENSE VOLUMES OF PHREATIC AND ARTESIAN WATERS IN NORTH DAKOTA.

The phreatic and artesian waters of North Dakota are very extensive and immense in volume, and the well trained brains and skillful hands of our people will without doubt in due time turn them to practical account in the better methods of farming, superinduced by practical common sense systems of irrigation or the proper application of moisture, as taught by the laws of nature, for the best attainable results in cultural pursuits.

ROCKS CONTAIN WATER.

All rocks, without exception, contain water. Fine sand takes in about one-third of its bulk of water.

The source of all underground water is the rainfall.—Prof. Robert T. Hill.

All salt-water wells have a low temperature.

IRRIGATION FROM A STUDENT'S STANDPOINT.

In the early agitation of the subject of forestry, but little was said of the subject of irrigation by foresters. But now all apostles of forestry contend that irrigation, or the proper application of moisture in the husbandry of the farm, is not only an advantage, but a necessity for the attainment of greater certainty, abundance and profit.

This trend of thought is exemplified in the views presented by Prof B. E. Fiernow, chief of the Forestry Division of the Agricultural Department. In his report to the Secretary of that department, he says:

"It appears now quite certain that those countries which do not rely upon the disposition of rainfall and snow water, as produced by the accidental, changeful, uncontrollable, and partly unknown conditions of climate, but which dispose of them in an artificial manner, guided by human ingenuity, namely, irrigation systems, produce with much greater certainty and abundance. This once recognized, the proper distribution of the available water supplies will *everywhere*—not only in the arid regions—become a question of immediate interest."

SAVE THE FORESTS OF THE ROCKIES.

"Inasmuch as the forests," says Col. E. T. Ensign, "serve as feeders for the principal streams of the district upon which the irrigation system of the Rocky mountain states depends for its maintenance, their protection is a matter of vital importance." This is true, but the same reason holds good for the protection of trees in the great plain-country east of it. The towering Rockies are the great head-land feeders of water for lands far east. With earnest solicitude all our loyal foresters watch what is being done to save those mighty forests from further destruction. And we in North Dakota, in particular, are interested in this great problem, for the snows and the waters conserved by the forests of these great uplands are the source to a great extent, we have reason to believe, of our great artesian supply.

MUST IRRIGATE AND FORESTIZE OUR COUNTRY.

When brooks dry up, stock retrogrades. Less moisture in the atmosphere, less crops. The Rocky mountains are fast deforestating and the violent storms and land slides are increasing, affecting all the country. With no forests to hold back and husband the snows and rains, destructive torrents follow in the spring and thence blasting drouths. Thus the supply of irrigation is cut off. Where the air is moist the leaves of plants absorb it, and send it down to the roots, and they develop fast, strong, healthy and hardy. Dry air develops root growth, and slow, feeble stalk growth. High altitudes educe rarity of air with dryness. Temperature lowers in the ratio of three degrees for every one thousand feet of ascent. Rainfall decreases with the latitude or altitude. Beyond sixty degrees north latitude the annual rainfall seldom exceeds ten inches. The only method by which such localities can be rendered suitable for human habitation with certainty of business progress, is by irrigation and forestry. The Dakotas are, in round numbers, elevated one thousand feet above the sea. But this is not the main cause of our atmospheric dryness. Here is the mid-continental region of North America. The intervening mountains between us and the oceans east and west, and great distances from the oceans prevent the rainfall of the oceanic storms from reaching us. To conquer a climate we must irrigate and forestize our country. Three things are necessary to success—water—water—water.

THE DUTY OF WATER.

It is estimated that in New Mexico it takes one cubic foot of water running night and day to irrigate 160 acres. In Colorado, the flow of one cubic foot per second throughout the irrigation season is sufficient for about 100 acres, and the same amount of flow from the Dakota artesian wells, in experienced hands, will irrigate successfully nearly 200 acres.

THE DEVILS LAKE ARTESIAN WELL.

This is one of the most interesting artesian wells in North Dakota. To be sure its flowage is not equal to some others, but this is owing principally to the want of proper boring and piping. But it is interesting because of its location upon the shore of Dakota's inland sea, the "Chautauqua lake of the Sylvatan State of the Union," and because it demonstrates the existence of the great artesian basin in the central part of our commonwealth, and that the flow and pressure are amply sufficient for many practical things, amongst which may be mentioned the following: Through direct flow and pressure in rubber tubes the water has been used with most favorable success in subduing and extinguishing dangerous fires of the city, the water being carried high and in ample and abundant volume. It is used extensively for stock, culinary and domestic purposes. Being soft it becomes excellent water for cleaning the hands and face and for bathing purposes. It contains numerous healthy medicinal properties and hence it is made available by many for various ills and complaints with the most gratifying results.

The mains and hydrants of the city are kept fully supplied with these waters which, being warm, rarely if ever freeze in winter, and they could be utilized to the best advantage for irrigation on the prairies contiguous to the city, and the power of the well is sufficient for operating much machinery, and this, too, without interference with any of its present uses.

REVELATIONS OF HIDDEN THINGS.

I never visit the "Chatauqua City" without a "pilgrimage" in devotion to this attractive well, and drinking of its limpid and pleasant waters. And those visits are always fraught with instructive lessons, for the spirit that animates, becomes attuned to the mystic elements and powers of nature which, in silent utterance, speak unto the mind and reveal their hidden forces and uses, and translating the revelations into human language, in glad, free, hopeful action, my lips and pen declare, if not wisely, with zeal and fidelity, the truth that water, the Providential bounty of nature, is the one great mighty element which, controlled and applied in an intelligent and scientific manner by the skillful hand of man in the husbandry of life, will enrich and bless the land and people, and with trees and forests to protect and adorn, re-Edenize the western world.

HISTORY OF THE WELL.

This well was sunk or made by Stacey & Co., of Aberdeen, S. D., and cost, it is claimed, near $7,500; depth, 1,440 feet; commenced to flow in September, 1889. At that time the flow was 60 barrels per hour, and May 10, 1890, the flow had increased to 150 barrels per hour, or near 150 per cent., being 79 gallons per minute and 3,555 barrels per day. Altitude, 1,459 feet above the sea; pressure, 25 pounds to the square inch; size of the pipe, 6 inches at the surface of the ground and 4½ inches at the top of the sand rock and 3 inches through and below the sand rock. Prof. G. E. Culver, of Vermillion, S. D., the eminent scientist, gave this well a thorough examination in May, 1890, and stated that the pressure would probably be three times greater than it was at that time, if the pipe should be cut off just below the rock which overlays the sand, or if the opening could be enlarged. And this is a reasonable conclusion, for the pipe below the rock is but three inches in diameter and is sunk into the quicksand, we are informed, some hundreds of feet, and this is being continually filled with sand, which greatly lessens the pressure and flow. These facts give promise that this never-failing well, by proper improvement in its piping, will become one of the best in North Dakota.

REMARKABLE ARTESIAN DEPOSITS.

At various depths below the earth's surface, in nearly all the grand divisions of land, and the islands of the sea, large artesian deposits have been discovered. With the exception of not over half a dozen, every state of the Union has some artesian wells. I name herewith some of these great deposits, and some of the deep and large flowing wells.

LARGE ARTESIAN DEPOSITS.

The Dakota Artesian Basin, or James River Basin, has, it is claimed, the largest artesian water supply in the world.

At Yankton, S. D., there are seven artesian wells within a mile of each other, yielding an average of 1,500 gallons per minute, and it is a remarkable fact that the flow and pressure has not decreased in the least, although the flowage has been steady and uninterrupted for several years.

The Waco, Texas, artesian field yields very large volumes of water.

In one township in California (Orange county) there are seen 400 flowing artesian wells, 200 to 400 feet deep.

Numerous good flowing artesian wells are in operation in the Sandwich Islands.

We now have good evidence that artesian wells were in active operation in China long before the sinking of the well in Artois, France, whence comes the name of "artesian."

According to reliable authority, at Charleston, S. C., an artesian well reached 1,900 feet below sea level, before ample flowage was obtained; at Galveston, Tex., 900 feet below, and at St. Louis, Mo., 3,000 feet below.

There is an artesian well at Passey, near Paris, 1,923 feet deep, with two and one-third feet bore at the bottom, giving a flow of 5,500,000 gallons per day, a great output, but much less than some of the 6-inch wells of South Dakota.

There are also other great artesian wells in or near Paris. At one town in France water has spouted eleven feet above the surface for more than 100 years. At Lilliers an artesian well has had an unceasing flow since 1126.

DEEP ARTESIAN WELLS.

Location.	Depth.
Rochefort, France	2,676
Louisville, Ky	2,086
Columbus, Ohio	2,575

FISH ABOUND IN ARTESIAN WELLS.

The sworn and reliable testimony of intelligent, observant men prove, without a doubt, that many fish abound, at times, in the waters of the artesian wells of North and South Dakota, and other states of the West. As far as I have been able to learn, the fish are always small, being near one to one and one-half inches long. They seem to be of the pickerel species, having eyes, and the same form and shape as those found in surface water. These fish have been thrown up in the waters of the artesian wells of Aberdeen and Ipswich, of South Dakota, and Manvel and Casselton, of North Dakota, and other places in the two states. What are the lessons taught by the presence of these fish, not infrequently found in large quantities? Can fish be propagated *underground* by human art? Does their presence prove the artesian waters have their source from surface water not far distant from the "fish wells?"

THE MEDORA ARTESIAN WELL.

In June, 1892, I visited and inspected this well, situated on the line of the Northern Pacific railway at Medora, Billings county, N. D., at a distance of one-half mile from the Little Missouri river. It is near 150 miles west of Bismarck. It had been the general conviction, even amongst prominent members of the Irrigation and Underflow survey of 1891, that no artesian wells existed under the "Bad Lands." But contrary to the general belief, in the early part of 1892, the artesian deposit was struck at a depth of 400 feet, giving a flow through a four-inch pipe of 28 barrels of water per day. A two-inch pipe carried the water 45 feet above the surface of the ground. The water proved to be as sweet and pleasant to the taste as the best well water in the State, and it had the quality of being as soft as rain water.

Since that time the well has been sunk to a depth of 800 feet, and the water, carried in a two-inch pipe, is elevated, by the pressure, 100 feet above the level of the ground, and its present water is soft and most agreeable to the taste. It is used by the Northern Pacific Railway company for its engines.

Analysis of the water of this well indicates the presence of hydrogen sulphide. (H_2S.)

Not a small importance should be attached to the discovery of large quantities of artesian water there in the very heart of the "Bad Lands," because it demonstrates the existance of an artesian deposit, tending to prove, in connection with the flowing artesian wells found in the eastern, central and northern part of North Dakota, that our State is underlaid in much, if not all, its parts, with artesian basins containing huge volumes of water, which may be used advantageously for irrigation and mechanical purposes.

ARTESIAN WELLS AT GRAFTON.

To Joseph Tombs, Esq., Grafton, N. D.

DEAR SIR: Will you have the kindness to answer as many of these questions as circumstances will allow?

W. W. BARRETT,
State Superintendent of Irrigation and Forestry.

The number of deep artesian wells at Grafton?.

Four.

Their names?

City Well, County well, Leistkow & Chandler's, Wm. Gilbert's.

For what used—for protection against fire, for irrigation, etc.?

City well used for fire protection; balance for laundry use and for stock. None used for irrigation on account of salt.

Cost of each well?

City well cost $3,700. Don't know cost of others.

Depth?

City well, 912 feet was drilled, but was filled up to a little less than 400 feet. Flow, 15,000 barrels per day.

Size of pipe?

City well, six inches; County well, three inches; others, two inches.

When was each well sunk?

City well in 1886; County well, 1887; balance later.

Pressure of each well?

About fifteen pounds per square inch.

List of small artesian wells?

There are probably in adjacent country 50 or 60 wells, varying from 100 to 250 feet deep, with principally the same depth and quality of waters, and different flows, from 25 to 1,500 barrels per day.

JOSEPH TOMBS.

MORE EVEN DISTRIBUTION OF PRECIPITATION.

Since the organization of the Weather Bureau the United States Government has appropriated millions of dollars to make observations, compile data and make reports. Thus a vast amount of valuable facts have been discovered and published, and among other thing it has been learned what is well known to the most casual observer, that there is often a vast difference in different localities in the temperture and precipitation, and also in the states and conditions of crops, of grain, and fruits, and other forms of vegetation. In some sections there is a great excess of rainfall, while in others there are large deficiences, where in many instances severe droughts prevail. The annual precipitation or rainfall throughout the world is calculated by the scientists to be about 30,000 cubic miles, sufficient to cover the whole land surface to a depth of thirty-three (33) inches, evenly distributed. This fact proves nature supplies sufficient moisture if properly distributed, to provide for the wants and necessities of all forms of vegetation throughout the world.

MAN'S MASTER POWER.

Man, it is discovered, has existed upon the earth for thousands of years and has made steady gains all along the march of time until he has become the master of many elements which obey his will and hands. His cunning is great and his wisdom profound; he sails upon the sea and navigates the air; he applies heat to water and evolves a power that moves the race, the grains, the fruit, and the animals from land to land; he harnesses the lightning and gathers the electric forces for the transmission of thought, the running of machinery, the lighting of the home, the city, the land and sea. Yea, what man has done in the way of inventions, discoveries and improvements, and the mastery over the elements and forces of nature, is beyond the power of lips to express or pen to portray. Then why cannot he, the sovereign of the earth, devise such methods or systems as will cause the precipitation of the globe to be more evenly distributed? Is it not possible for him to consummate such a desirable and beneficial purpose or has he reached the limit of his ability, and can do no more? Nay, man is but in the infancy of his development, and what he has thus far accomplished is but a sure prophecy and evidence of future progress and greater mastery for practical good over the things of nature, especially in the direction of the control of rainfall.

WHY STRIVE FOR A MORE EVEN DISTRIBUTION OF PRECIPITATION?

But the objector, with the view of provoking thought, or of unwise condemnation, may say—"It cannot be possible that man can influence the rainfall—that alone belongs to the order of nature or providential bestowment or withholdment. It is folly to waste thought and time upon the question of a more even distribution of precipitation; or to control the moisture of the sky in anyway, or to experiment in that direction. Of course here in arid America we need more rainfall to subdue the drouths and simoons and insure bountiful crops, but it is senseless to seek for the unattainable. Let us patiently endure our poverty and want, and for our fidelity trust for a reward above."

PROVIDENTIAL BLESSINGS COME IN LARGE MEASURE TO THOSE WHO EXERCISE PRACTICAL COMMON SENSE IN THE ECONOMIC DEVELOPMENT OF THE STATE.

Brains and hands were given for the subjugation of the earth and to win its increasement by keeping the things of nature in proper balance and true relationship, and affluence and happiness, not poverty and suffering, is the true order of nature to the thoughtful and wise, and providential blessings come in largest measure to those who exercise practical common sense in the economic development of the state, through an acquired knowledge of and the manipulations of the elements and forces of land, water, and sky for the highest good of mankind.

MAN CAN INCREASE OR DECREASE THE AMOUNT OF PRECIPITATION.

Man has not, as yet, reached that eminence by which he can command the moisture of the sky to come as needed at the bidding of his will or cunning art. But it can be clearly proven that by the destruction or rearing of large forests he has and can increase or decrease the volume of rainfall.

A majority of the foresters contend that where vast forests have been cut down or removed, the rainfall has lessened, and where large forests have been restored the precipitation has increased. Prof. Becquerel states: "St. Helena was fully forested when discovered in 1502, but the introduction of goats and other causes led to the removal of its forests. Heavy floods and severe drouths were the result; replanting of forest trees towards the close of 1700 resulted in a more *uniform rainfall and its better distribution.* Subsequent destruction of the forests have again brought back the original condition of affairs." The same author also states that when discovered in 1815, the Island of Ascension "was barren and so destitute of water that supples were brought to it from the mainland. The effect of planting trees resulted in increased rainfall." The chief of the forestry division of the United States Agricultural department, Prof. B. E. Fernam, states: "While the forest everywhere does not increase precipitation over its own area, yet a large system of forests over an extensive area will influence the quantity of precipitation over and within this area."

A reputable and conservative writer, who has given this subject much study, under a recent date makes the following statement of facts:

Prof. Harrington cites reports from sixteen meteorological stations in Germany that are always near forests, and sixteen like stations near regions without forests, and in most every instance the forest station shows the more rainfall. That at Lintzel, was made a date of comparison with a series, being a reforested district. The results are given after the accumulating tree plantation was five years old, and it was discovered that commencing 1882 and ending 1888, the percentage of rainfall increased steadily with the extent and height. Experiments were also made on forested and non-forested elevations, covering vast areas, and again the forest led in percentage of rainfall until at the highest point it was nearly double in surplus. After mentioning striking instances in India, Java and Celebes, covering many years of experiment, and allowing a margin of fifty per cent. for errors and general rainfall, the professor cautiously adds: "There yet remains an appreciable addition which might be attributed to the growing forest; * * makes a good presumption that a forest does actually increase the rainfall to an appreciable percentage."

IMMENSE DESTRUCTION OF THE FORESTS.

How sad is the thought that within the union of the states, east and west, north and south, through ignorance and the thirst for present gains regardless of future losses and calamities, the trees and forests are being indiscriminately cut and consumed for various purposes, and wantonly destroyed by fires, without proper reconstruction, at the rate of 17,000,000,000 cubic feet each year—(12,000,00,000 cubic feet for the cut and 5,000,000,000 cubic feet of loss by fire) in *excess of the annual growth*—while the entire forestry area within the United States is now but five hundred millions (500,000,000) of acres.

THE SURE WAY THAT LEADS TO DROUTHS.

This vandalism, this thoughtless or criminal interference with the providential provisions of nature, this disregard of the divine law thereof, is but the sure way that leads to drouth and the unbalanced or destructive operation of the elements given to man not for injury, but to study, control and use for the best conditions of mortal life.

THE TRUE SYSTEM FOR INCREASING PRECIPITATION.

The systems or methods for the increasment of precipitation have now become apparent, to a large degree to the studious and observant of the present time, and they are systems that have always been advocated by the writer from the commencement of this work in 1889, towit: The protection of the young and thrifty trees, and the "fittests," the economic use of the older and larger ones, the removal of all litter and underbrush, the careful exclusion of forest fires, and the planting and culture of large acres of trees and forests over the treeless lands of the West and East. Such developments, in connection with the surface water system outlined in other parts of this report, reservoirs and irrigation waters, with those of the sea and other natural bodies of water, will furnish the sky, through evaporation, with a volume of moisture that will tend to furnish that amount of precipitation which shall destroy the drouths and laden the earth with voluminous crops, responsive to the intelligent tillage of the soil.

THE BENEFICENT WORK OF THE HIDDEN FUTURE.

Forestal reformation or development as outlined herewith, receiving due attention, gives the basis for meteorological experimentation, when other agencies, perchance electricity or modifying gases, may be employed to influence the winds and temperature, leading to precipitation at times and in quantities needed—the master work of man's latent wisdom or to be acquired scientific skill and power, to become manifest in due time by the orderings of divine providence in the production and control of artificial rainfall for the dearest and most beneficent good of the children of men.

A LAW OF ECONOMIES.

It is known that the seasons of the largest crops are those in which the rainfall has been sufficient and most evenly distributed, and especially when most needed. Does not this fact reveal a law of economies? The equalization of moisture in form of rain guards against drouths and conduces to certainty of crops and profits. Man cannot yet master the rainfall by wisdom's greatest skill, but he can equalize the moisture by proper and intelligent irrigation, where the same can be applied through sufficient supply of water, and thus he may be made practically independent of failures resultant from drouths and hot winds.

This idea is applicable in humid as well as arid regions. And this fact is well understood in various parts of our country and in Europe. Lombardy, according to official record, has an annual rainfall of 36 inches, and yet there irrigation is more generally practiced and made highly remunerative, the writers state, than in most any other part of civilization.

IRRIGATION AREAS AND ARTESIAN WELLS OF THE ARID REGION.

Through the Irrigation Inquiry office connected with the Agricultural Department, the following information was obtained from Col. Richard J. Hinton, chief in charge of the Irrigation and Underflow Investigation of 1891. At that time, the case of the fall of 1891, the status of irrigation in the West was as follows:

IRRIGATION AREAS AND ARTESIAN WELLS WEST OF THE NINETY-SEVENTH MERIDIAN.

State and Territory.	Acreage.					Number of Artesian Wells.
	Under Ditch.			Cultivation.		
	1889.	1890.	1891.	1890.	1891.	
Arizona	529,200	643,450	660,000	310.100	315,000	*45
California	3,294 000	4,044,000	4,500,000	8,444,000	3.550,000	3,500
Colorado	2,813,273	4.082,788	4,200,900	1,585,000	1,757.162	4,500
Idaho	715,500	1,181,500	1,230,000	327,000	330,000	12
Kansas, west of 97° of longitude	500.000	860,010	900,000	100,000	120 000	250
Montana	986,000	1,100.000	1 250,000	400,000	410,000	36
Nebraska, west of 97° of longitude	50,000	65,000	200,000	10,000	40 000	100
Nevada	142,000	150,000	150,000	75,000	00,000	76
New Mexico	638,455	677,315	700,000	450,000	465,000	10
North Dakota	....	1,000	2,500	1,500	2,000	†670
Oregon, east of Cascades	75,000	100,000	125,000	46,000	45 000	6
South Dakota	100,000	110,000	100,000	22,000	54,000	†250
Texas, west of 97° of longitude	200 000	240.000	250,000	160,000	160.000	‡1,000
Utah	700,000	700,000	735,226	413,000	423,364	§2,524
Washington, east of Cascades	75,000	150,000	175,000	60,000	75,000	16
Wyoming	1,946,876	‖2 172 781	‖3 038,481	‖175,000	‖180,000	6
Total	12,765,304	16,367,794	18,286,207	7,577,600	8,026,526	13,695

NOTE—The figures of this table are necessarily estimates, made by the Irrigation Inquiry, but they are all well within the facts. All the wells given come within the definition of "positive" artesian water adopted by this office.

*The first successful artesian well in Arizona was drilled in 1881; the total given was reached by 1888.

† The deep artesian wells in Dakota, now completed, number 105; the shallow flowing or drift wells are estimated at less than 800. The State engineer reports over 100 township wells

contracted for and in process of construction, and about 250 more private enterpirses are reported. In North Dakota there are nineteen deep flowing wells, and about 650 flowing shallow wells in drift deposits in the Red River basin.

[‡] In Texas, in 1890, about 700 flowing wells, deep and shallow, were reported upon, and atleast 800 more have since been bored.

[§] The Utah total is the statement of the United States census accepted as correct in the Territory, up to July 1, 1890. The number has since been increased sufficiently to warrant the estimate of 2.800. These are all shallow depth, flowing wells, supplied from drift deposits. This is an addition of 276 wells, making the total 13,971.—Statement of Territorial experts.

[‖] From report of State Engineer Mead, 1889-'90, and Mr. P. L. Naismith, assistant engineer, for 1891, made to this office. The figures given for 1891, as "under ditch," are from the State records; those for 1892 include 856,700 acres as covered by works in process of construction or projection under prior appropriations.

NEEDED FACTS PRESENTED.

It is very essential to give a description, at least to some extent, of the artesian basins of our State, the artesian wells, their location, the strata of the borings and an analysis of their waters, as far as the same have been made, etc. The reason for these presentations are these: Every citizen of our commonwealth must become acquainted with these essential facts, in order to learn of our artesian resources and the progress made to date, as well as the possibilities of irrigation in our State. Hence these things, involving much data and many valuable facts, are treated in as condensed form as the nature of the subjects will allow. And as these things are of such vital importance, I have deemed it best to use some of the facts contained in my former report.

THREE CLASSES OF ARTESIAN WELLS IN NORTH DAKOTA.

In North Dakota we have three classes of artesian wells arranged in the order of their depth and pressure.

The first class of wells have their source in the deep-seated water-bearing strata or the main water-bearing rock, with a heavy flow and generally a high pressure. This class includes the following wells: Oakes, Ellendale, Jamestown and Devils Lake. These are some of similar wells of South Dakota, to-wit: Hitchcock, Day, Harrison, Huron, Springfield, Armour, Woonsocket, Ridou, etc.

The second class of wells are those having a depth of 200 to 400 feet and a pressure of ten to thirty pounds to the square inch. Included in this class are the Hamilton and Grafton wells. This latter well was bored to the depth of 912 feet, but no flow being found below 390 feet, it was filled up to that point, from whence there is a flow of 60 gallons per minute, with a pressure of twelve pounds per square inch when the flow is shut off. Prof. Hay says of these wells: "These are usually spoken of as deep wells because the borings were made to depths of 900 to 1,600 feet. It was therefore assumed that the source of supply was the same as that of the James River basin. But it is a fact that the water does not come from the bottom of the wells, and that the pressure is so much less than would be expected if the source were the same. This will be understood when it is known that the elevation above sea level at

Woonsocket is just over 1,300 feet, and the elevation at Hamilton and Grafton a little over 800 feet. If the wells at these places were supplied from the same source, the surface pressure at the lowest elevation would be much the greater. The very reverse is the fact. Hamilton has a pressure of twenty-six pounds, Grafton eleven pounds and Woonsocket 147 pounds to the square inch."

There are numerous wells in the Red River valley having a pressure of less than a pound to near twenty-five pounds to the square inch. The deeper ones seem to have their supply below the highest of the shale beds, namely, within the cretaceous formations. It seems probable the shales have been cut away at some points in the section through which the waters from sands and gravels of the drift have made their way.

The wells in the vicinity of Grafton range from 200 to 390 feet, and their pressure is nearly uniform of ten to eleven pounds per square inch. All the wells of the Red River valley, including the new one at Hillsboro, receive their water from the Pleistancene gravels.

LAKE AGASSIZ.

The Red River valley is the bed of an ancient lake, known to geologists as Lake Agassiz, which exceeded in area that of the present Lake Superior. For many years great ice sheets rested upon the land at that point. Finally the wall moving northward, left large deposits of gravels, sands, clays and boulders. On these there was deposited fine sediments from the waters of the lake, leaving the soil of this now level valley in a most fertile and prolific state, whereby it has been called the "garden plain of the Northwest." These sands and gravels are now charged with water which has filtered down from the exposures on the shores of the ancient lake. These wells do not derive their force from higher bodies of surface water, as from the Pembina mountains or Devils lake. This is made evident from the fact that the pressure would be higher from such a source. In ridge a few miles west of Grafton the water barely flows above the surface. To the porous strata of old ridges we must look for the channel by which the meteoric waters find their way to the subterranean sheet or reservoir underlying the old lake bed.

There is a slight descent of the valley to the north for 160 miles, as may be seen by the altitudes of the following places as given by "Garrett's Dictionary of Altitudes:"

Fargo	905	feet above the level of the sea
Hillsboro	901	feet above the level of the sea
Grand Forks	837	feet above the level of the sea
Manvel	827	feet above the level of the sea
Grafton	831	feet above the level of the sea
Hamilton	831	feet above the level of the sea
Neche	838	feet above the level of the sea

The ridge referred to lying west of Grafton extends southward all one way to Tower City, Cass county, and beyond. It rises gradually to the west until it borders on the valley of the Cheyenne. However, there are local depressions at various points, as in the valleys of Park river and the Little Pembina. Prof. Hay states: "The Pembina Mountains are clearly not the origin of phreatic waters of the Red River valley, but the coming to the surface on their flanks of the underlying shales points out the fact that water on the surface of the shales will be forced eastward and the supply will be kept upon the edges of the valley. The sources of water, then, are not far to seek. They are in the gravel ridges, on the sides of the Red River valley, the old basin of Lake Agassiz, which receives the rainfall and passes it through their porous beds to similar beds beneath the more compact silt and alluvia of the old lake bottom."

The third class of wells of our State are those having less depth than the second class, the source of their waters, without doubt, being local gravel beds resting upon underlying shales or clays.

TWO GREAT SYNCLINALS.

Located between the Great Lakes and the Rocky mountains are two vast, low synclinals. The Mississippi river is the axis of one, and the Missouri river the axis of the other. Or expressing the facts in other words, the upper Mississippi river system forms one basin and the upper Missouri system forms the other, each having its system of surface and phreatic or tellurial drainage. The Mississippi river system contains numerous artesian wells, but as there has been no systematic examination, the artesian possibilities are but imperfectly understood. The Missouri system has received governmental examination, and hence a better knowledge prevails in regard to the same.

ARTESIAN BASIN OF NORTH DAKOTA.

According to present light upon the subject, we have two artesian basins in our State.

THE JAMES RIVER VALLEY ARTESIAN BASIN,

which is often called the 'Dakota artesian basin,' covers a large portion of North and South Dakota, extending north and south nearly 350 miles, and some geologists claim 400 miles, and at least 100 miles from east to west. The basin consists of a low, broad and deep synclinal, composed of numerous and copious bearing strata, with its axis nearly north and south. Investigations up to the present time indicate the boundary to be as follows: Its eastern border is in the eastern part of the Dakotas, involving, perhaps, as some claim, the western part of Minnesota, and its western limit is in the foothills of the Rocky mountains. The eastern edge is approximately defined by a line passing through Vermillion, Scotland, Mitchell, Iroquois, Clark, along the western ridge of the "Coteaux" to Andover and thence northeastward to the State line. The eastern border is as yet but imperfectly defined. The same is true as regards the northern line. This land has the general form of the bottom and sides of a great lake. We trace along its eastern line. Here is found the uplifted Laurentian gneiss on the western border of Minnesota, which forms the divide between the Mississippi and the Missouri. From this summit at Lake Benton, Lincoln county, Minn., the locality being at least 1,800 feet above sea level, there is a general descent until the James river is reached, where there is a gradual ascent to the foot of the Black Hills. As the hills dip to the north and east their waters enter the basin, and the drainage of near one-half of the state of Wyoming, flowing northward, also finds its way into the basin. The Rocky Mountains in Montana, on their eastern slope, pour their immense volume of water into this great artesian field. Along the southern boundary of the British possessions we discover the "divide" between the Missouri and the Saskatchewan, preventing the escape of the waters in that direction. Down from this "divide," the Turtle and Pembina mountains, and all the high altitudes of table lands and plains, there flows beneath the surface, through the porous, transmitting strata, the many waters to feed the great underground reservoir. Thus, from the east, north and west there descends, from year to year and age to age, the measureless rains and melted snows which, centering beneath the now dry, ancient Lake Dakota, drained by the James river, reappear through the borings of the artesian wells with a flowage unequalled in all the lands of the earth.

The source of supply of the Dakota artesian basin is as indicated above. The greatest volume is supposed to come from the Rocky mountains. To this must be added the rains, melted snows, freshets, springs, streams, lakes, rivers and all the phreatic waters from all the mountains, uplands and valleys on the borders and the outskirts and within the great synclinal, where through percolation and imbibition the vast and deep porous strata becomes saturated with these waters, a large percentage of which swells the artesian tide or deposit, responsive in upward flow to the practical skill of human intelligence.

The Dakota sandstone is the water-bearing rock. The cretaceous and the younger rocks are the only ones involved, and the Dakota sandstone is the water-bearing rock. This rock comes to the surface or is exposed to view along the Big Sioux river and in the region of the Black Hills, both in South Dakota. It has a gentle dip to the northwest and the surface rises in the same direction. It also appears along the drainage channels of the Yellowstone and Missouri rivers. It is a soft and porous rock and possesses the property to imbibe water freely and to allow the same to be transmitted through it, and that, too, even for long distances. This rock (sandstone) in the Dakotas is known to have varied degrees of hardness. At times it is discovered to be a bed of loose sand. By gradations from this it becomes a dry, hard and very compact rock.

The Red River valley wells are not connected with the James River valley artesian basin. The same is true of the shallow wells of the southeastern part of South Dakota.

It is a mooted question whether water will rise to the surface in the higher altitudes of the basin. The pressure manifested by the best wells in the James River valley can raise the water no higher than 2,000 feet above the bed of the sea.

Artesian Springs.—In the valleys of the Missouri, Big Sioux, James and Vermillion rivers the water escapes in the form of artesian springs. This is owing to the thin covering beds of the Colorado group. These springs appear throughout the country between Chamberlain, on the Missouri, and Sioux Falls, S. D. By many this leakage is thought to explain the diminution in the flow and pressure manifested in the wells of the southeastern part of the basin. They also exist in Rolette and Emmons counties, N. D.

River Valleys.—The river valleys are many in North Dakota. They are conspicuous because of their extent, fertility and great beauty. Amongst the number worthy of mention are the following, namely: The Red river, the James, the Cheyenne, the Missouri, the Mouse and the Mauvaises Coulee. At Brookings, S. D., is a depression, forming the valley of the Big Sioux river, and one at Pierre, constituting a valley of the Missouri.

The Coteaux.—The swells of land at Arlington and Highmore, and also those further north in North Dakota, east and west of the James river, do not affect the underlying formations. Under the drift, the shales in both Dakotas are in position. These ridges (the coteaux) were left when the valleys of the Missouri, the James and the Big Sioux were eroded by the denudation of the receding waters. The drift on the ridges of the coteaux is nearly one-third deeper than in the surrounding valley. The Coteau du Prairie, east, and the Coteau du Missouri, west of the James river are the principal highlands of that nature in North Dakota,

Underlying Beds.—The Dakota rests directly on the coteaux in the southeastern section of the basin (in South Dakota). It is not known how far west or north this condition prevails. The quartzite—known as the Sioux Falls quartzite—appears at Sioux Falls, Tyndale, near Alexandria, Bridgetown, Vilas, Plankinton, White Lake, Kimball and other points in South Dakota, where, in nearly every instance, the same has been met in sinking wells.

It is not impossible that the trias or carboniferous, may be the underlying rock in the northern and northeastern parts of the James river district.

In the Red river valley there appears a complete absence of the cretaceous series, the drill, penetrating the lacustrine and drift deposits, enters the red beds, or it may possibly be the red, sandy shale of the upper carboniferous.

When the matter of structure is considered the James river valley or Dakota basin may be considered as extending west into Nebraska, as there is no geographical break in the cretaceous beds along the line between South Dakota and that state. Indeed, some wells, few in number, have been in operation quite a length of time in northern Nebraska which are clearly in the same basin as those found on the north side of the Missouri.

Artesian Wells in High Latitudes.—There is no failure of water to the east until the real edge of the basin (James river valley) is reached. In the northern part of North Dakota, whilst artesian wells doubtless underlie the surface, the depth becomes the important element of limitation. Can sufficient force be obtained to lift the water to the surface where the altitude is 2,000 to 2,500 feet? If flowing wells can be developed in such elevated sections it will probably be due to some of the following causes, to-wit: The water-bearing strata may be found at less depth than at points farther east or south; the sandstone may be composed of coarser grains, allowing freer flowage, and the finer sandy parts becoming compact and firm, may dam the water, causing accumulation, and as the surface is somewhat lower than the supposed source, the water may rise through the opening to or above the surface. And there may be found water-bearing strata at higher levels than the Dakota sandstone.

In the present limited knowledge of artesian developments, the only clear understanding of artesian deposits and flows is to drill deep enough to settle the question.

No Diminution of Supply.—Whilst there is a limit to the number of wells that can be supported without diminution in all artesian deposits, thus far the supply of the James river valley has not apparently lessened. Some wells at times have given a decreased flow, but the cause has been found in some obstruction in the pipes, and not the lowering of the deposit.

COMPARATIVE DEPTHS OF SOME OF THE WELLS IN THE JAMES RIVER BASIN.

Towns.	Feet Above Sea Level.
Harrold	1,061
Huron	1,045
Iroquois	1,001
Mellette	892
Harrold	801
Woolsey	845
Huron	825

Huron	848
Iroquois	801
Tracey, Minn	858
Harrold	398
Highmore	339
Miller	390
Woolsey	396
Huron	380
Ellendale	360
Frederick	365
Aberdeen	397
Mellette	384
Redfield	336
Hitchcok	389
Huron	325

	Feet Below Sea Level.
Jamestown	85
Asylum	54
Devils Lake	47
Deloraine, Manitoba	over 200
Rosenfeld Junction, Manitoba	780
Moorhead, Minn	1,000

In the Moorhead well the lower flow (the third flow) was struck at 950 feet, 49 feet below sea level, but no water was found below that point. This well penetrated the granite 600 feet. It is not a flowing well, the water rising within 50 feet of the surface. It is an artesian well of the negative character.

Three Water-bearing Strata.—By an examination of the foregoing statements, we discover a water-bearing sandstone which is practically level at about 850 to 875 feet above the sea level, and near 350 to 370 feet above the sea appears another. Then another flow is formed below sea level. These facts are worthy of investigation, for they tend to prove a general law of artesian deposit in the Dakota basin.

Deeper Artesian Deposits.—Facts multiply which seem to prove that large artesian deposits can be found at lower depths, perhaps near or below sea level, in the Dakota basin, and it may yet be demonstrated by test wells that the artesian strata underlies the great Sioux Falls quartzite. Indeed, the evidences are already strong in support of this theory.

General Dip of the Sandstone.—It is generally supposed, based upon good evidence, that the water-bearing sandstone has a general dip, of regular form, northward through the basin.

A Water-bearing Stratum Pinched Out (?)—The Ellendale well is 1,087 feet deep; the Jamestown well 1,476; difference 388 feet; the Devils Lake well, 1,520; difference 433 feet. Now, why this great difference between the Ellendale and the two last named wells? It is found one locality may have a water-bearing formation so thick and porous as to furnish an ample volume of water, whilst another locality, even but a short distance away, may give but a meager supply. This is accounted for in two ways. The stratum may be very dense or quite impervious, thus preventing but small imbibition, or the stratum may be nearly pinched out. Thus it is possible the Ellendale water stratum may be entirely pinched out at Jamestown and Devils Lake, where the source of supply is found in the next general stratum, just below the sea level. Some geologists are of the opinion that the water-bearing sandstone of the artesian basin, in the first 1,000 or 1,200 feet, is entirely lacking north of Ellendale, but no good reason for such a theory has been adduced. This pinching out of certain water-bearing strata, in well known large artesian fields or basins is probably not general, but local. Therefore, aside from increased altitude, it is not unreasonable to look for flowing wells north of Ellendale, within the Dakota basin, whose supply may be no deeper than that of the latter well.

THE RED RIVER VALLEY ARTESIAN BASIN.

This basin occupies the site of the ancient Lake Agassiz, now a dry and prolific plain. It extends into Minnesota and Manitoba. Recent investigations prove it laps to some extent on the north end of the Dakota artesian basin. Its southern end is in the neighborhood of Fargo, and it follows the Red River of the North in the eastern part of the State to Lake Winnipeg in British America.

A THIRD ARTESIAN BASIN.

Evidences seem to multiply tending to prove the existence of a third artesian basin, namely, the Devils Lake Artesian Basin.

ENLARGEMENT OF THE AREA OF ARTESIAN BASINS.

The conditions as pointed out in regard to the flowing wells of the Red River valley will probably be discovered to exist beneath the bottoms of the Park river and the Cheyenne river valley, and also at points that may be an extension of the old Lake Agassiz.

There are many things to favor the conclusion that flowing wells, being in the vicinity of the ceaseless flow of the Devils Lake well, may be found, though probably at considerable depth, at or in the vicinity of Church's Ferry, Rolla and Minot.

The Axial Line.—Let us draw the axial line; it will be instructive. We commence on the Missouri, on the ninety-eighth meridian of longitude west of Greenwich, and run a little west of north, crossing the ninty-ninth meridian near the southwest corner of Cavalier county. This locates some of the most remarkable flows in the Union. It passes near the following wells: In South Dakota, the Springfield well, which has the largest flow of water, 3,290 gallons per minute, in the Dakota basin; Mitchell, two wells; Woonsocket, three wells, one of which flows 1,150 gallons per minute; Huron, five heavy flowing wells, the total flow of the four being 5,114 gallons per minute; Hitchcock well, flows 1,240 gallons per minute; Aberdeen, five wells having large flowage. In North Dakota, Ellendale well, flow, 700 gallons per minute; Oakes well, 817 gallons per minute; Jamestown, two wells, the largest flowing 460 gallons per miute, and the Devils Lake well flows eighty-two gallons per minute. We examine the country in North Dakota touched by this tracing, and the topography, the drainage, the general surface conditions and the many other favorable indications, taken in connection with our knowledge of this great central artesian flowage, all tend to strengthen the conviction that along this line in our State, particularly in the neighborhood of the water centers, Oakes, Ellendale, Jamestown and Devils Lake, there may probably be found extended fields of artesian deposits within the main water-bearing rocks of the great James river or Dakota basin.

In the vicinity of Jamestown and Devils Lake, on account of the high altitude and the depth of the artesian stratum, the wells may be deep and the pressure low, though the flow may be ample, as is the case with the Jamestown well.

Prof. Robert Hay is inclined to think an artesian flow of some force may be obtained at Carrington, Foster county. In speaking of the prospects in the neighborhood of Jamestown, he says in his final report, 1891, page 24: The pressure of the water at Jamestown would barely suffice to raise it in a closed pipe a little over 200 feet. The Coteau du Prairie east and the Coteau du Missouri west of the James river, on the Northern Pacific railway, rise to considerable height above the level of the valley. Of these known facts only one is favorable to the expectation of finding artesian flows east or west of the Jamestown well from the deep-seated water bearing stratum; that is the pressure and flow of the Jamestown well. East or west of that well, at elevations not exceeding 200 feet above it and not at any great distance, we should be warranted in expecting the drill to give artesian water at depths similar to that of Jamestown. West of Jamestown the strata lying above the water-bearing zone are probably thicker and the well-boring would have to be deeper, besides the extra depth due to increased elevation. Eastward it is probable the reverse is the case, and that the water zone would be reached at a less depth than that indicated by the increased elevation.

Again this eminent geologist says: "It is highly probable artesian water can be had at least in parts of the valleys of the Cheyenne and White rivers and the portions of the Mauvaises Terres."

We discover the wider and more thoroughly the Dakota basin is examined and tested, the greater becomes the extent and capabilities as an artesian supply. Its future development is full of the most promising results.

THICKNESS OF THE DAKOTA SANDSTONE.

The Dakota sandstone which underlies the James River valley consists of a very soft, porous, whitish-colored sand, the thickness of which is unknown. It has been penetrated with the drill at Huron to a depth of forty feet; Woonsocket, fifty feet; Springfield, sixty-two feet, etc. Some geologists claim this sandstone in some places is even 400 feet thick. It lies below the surface from 600 to 1,800 feet.

THE DIP OF THE ROCK.

The records of the wells show this water-bearing rock (the Dakota sandstone) dips to the north. On a line from Yankton to Devils Lake the depth is 830 feet, being about 2$\frac{3}{10}$ feet per mile, whilst the surface dips to the south from Devils Lake on an average of $\frac{8}{10}$ feet per mile.

VARIATIONS OF PRESSURE.

At the top of the wells the pressure varies from twenty to 167 pounds per square inch. The area of the greatest pressure, determined from the existing wells, is found to be in the central part of South Dakota, whilst the greatest pressure in the water-bearing strata is near Jamestown, N. D.

According to seemingly good authority, water has been thrown into the air by the *hydrostatic pressure, which is the force that lifts the water of artesian wells*, to a distance of 100 to 140 feet.

THE ARTESIAN SUPPLY INEXHAUSTIBLE.

It has been estimated we have even in but one basin, the Dakota or James River Valley basin, a body of water, infilling the porous water-bearing rock, equal in volume to that of Lake Michigan, giving forth through the bearings in massive flow, or in silver spray thrown high into the sky.

I have often stood beside those mysterious wells, stirred with the magnitude of the hidden elements upthrown in ceaseless action from year to year, with scarcely a change in the pressure and flow. Nature has hid her gold and silver and priceless gems within the rocks of the earth, deposited there her petroleum until needed for human use, and when man has so far advanced as to discover the fruitfulness of water, lo! there comes the revelation of

THE GREAT UNDERGROUND SEAS,

which utilized by the intelligence and scientific skill of mankind, shall become the motor power of machinery, the producer of electric lights and the great primal developer of grain and fruit for the enrichment, comfort, peace and happiness of the race.

SOME OF OUR HEAVY FLOWING WELLS, THEIR GEOGRAPHICAL STRATA, ETC.

Court Well.—Located in Sec. 11, T. 440 N., R. 55 W.; town 2½ miles northwest of Buffalo, county of Cass, State of North Dakota. Owned by H. E. Sargent. Completed in summer 1889. Drilled by George Frazer. Depth, 600 feet. Cost, $3,200, or $5.33 per foot. Flow, 12 gallons per minute. Pressure 45 pounds per square inch when flow is shut off. Temperature of water, 52 degrees. Elevation above sea level, 1,190.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil and clay loam	15	15
Clay	185	200
Marl	100	300
Clay Marl	220	550
Vein water	1	551
Clay marl	49	600

This well is situated on the table-lands between the James river and the Red river of the North. The drainage at this point is into the Red river, whose waters finally reach the sea at Hudson bay. Although this locality is near the continental divide, its elevation above the sea is little less than 1,200 feet. The log of this bore and the next two succeeding ones show very different formations from those which occur in the James river basin, as shown by the logs, the most notable difference being the absence of solid rock. The whole matter penetrated thus far in this vicinity indicates that it is a deep deposit of alluvial matter in a lake which at one time existed in this section. Deep bores might reveal the existence of a lower formation of rock similar to those found to the west and south, but to our knowledge none have been made deep enough to determine this question. The water from the well is a little salty. It is used for stock purposes. The bore is cased with 150 feet of 3-inch casing, 250 feet of 2 inch, and 550 feet of 1½ inch. All of these start from the top.

Staples Well.—Located in Sec. 12, T. 140 N., R. 54 W.; town 6 miles northeast of Buffalo, county of Cass, State of North Dakota. Owned by Staples. Completed summer of 1889. Depth, 514 feet. Cost, $1,500, or $2.92 per foot. Flow, 25 gallons per minute. Pressure, 50 pounds per square inch when flow is shut off. Temperature of water, 51½ degrees. Elevation above sea level, 1,170 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil	3	3
Blue clay	300	303
Black shale	20	323
Blue clay	177	500
Layers of clay and holes (no sand)	14	514

The quality of water from this well is good. It is used for watering stock and for household purposes. It has a continuous and free discharge, but on stopping the flow the pressure runs up quickly to 50 pounds per square inch. It is cased with 180 feet of 3-inch casing and 514 feet of 1½-inch, which starts from the top. On the lower end of this is 7 feet of wire screen, made of four thicknesses of wire netting.

Tower City.—Located in Sec. 19, T. 140 N., R. 55 W.; town of Tower City, county of Cass, State of North Dakota, Owned by the Northern Pacific Railroad company. Commenced fall of 1881. Completed June, 1882. Drilled by Charles Petsold. Depth, 716 feet. Cost, $3,200, or $4.47 per foot. Flow, 20 or 25 gallons per minute. Pressure, 53 pounds per square inch when flow is shut off. Temperature of water, 57 degrees.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil	3	3
Yellow clay	30	33
Blue clay	60	93
Blue clay (sticky)	327	420
Soft gray sand rock	24	444
Clay getting softer	116	560
Flowing mud; had to mix with sand to get it out	100	660
Hardpan, gravel and rocks; broke through into flowing water	56	716

This bore was put down by the Northern Pacific Railway company. The flow from this well supplies a public watering place for the town. It is cased to 420 feet with 6-inch casing. Inside of this is a string of 4½ inch, which reaches from the top to the bottom of the bore. The water is hard and contains some minerals. The pressure reaches 40 pounds instantly and 53 pounds in half an hour after being closed. The elevation due to the pressure of this well and the two preceding ones is almost exactly the same, namely 1,291 feet, which is 139 feet below the surface of Devils lake, which is 80 miles to the northwest. There are not a sufficient number of borings in this part of the country to determine the extent and direction of the dip and other features of the Tower City artesian basin. It is not difficult to find a large number of small lakes and running streams of water that have an elevation sufficiently above the top of these wells to give the pressure they have. If the other conditions are favorable to transmit the water on the surface to these wells, it is comparatively easy to account for the water supply for this basin. The James river, even at its lowest elevation in North Dakota, is high enough to supply the pressure that the water has in this basin.

Bismarck Well.—Located in Sec. 4, T. 138 N., R. 80 W., town of Bismarck, county of Burleigh, State of North Dakota. Owned by city of Bismarck. Drilled by Swan Brothers, Andover, S. D. Completed in 1883. Depth, 1,315 feet. Elevation above sea level, 1,756 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil and yellow clay	70	70
Lime rock	5	75
Blue shale	25	100
Black sandy shale	25	125
Blue shale	55	180
Black shale	5	185
Bright green shale	5	190
Blue sandy shale	190	380
Brown shale	16	396
Blue shale	104	500
Black sandy shale	55	555
Blue lime rock	5	560
Black sandy shale	60	620
Gray soapstone	272	892
Blue lime rock	8	900
Soapstone	340	1,240
Iron pyrites and lime	10	1,250
Soapstone	65	1,315

This bore was put down for obtaining a water supply for the city of Bismarck. The top of the bore is 120 feet above low water in the Missouri river at this place. No flow was obtained at a depth of 1,315 feet. Work was stopped at this point, with the supposition that the bore was deep enough to reach the James river artesian water-bearing rock, if such existed at Bismarck. Comparing the log of this bore with those in the Dakota basin, and also comparing the elevation of the surface and the bottom of the nearest artesian wells to the eastward, which are at Devils Lake and Jamestown, it will be seen that this bore should have been carried down at least 500 feet farther to reach the same rock. The bottom of the Jamestown well, 100 miles east, is 85 feet below sea level, while the bottom of this bore is 441 feet above, making 526 feet yet to go to reach the flow, providing it is in the same horizon here as at Jamestown. From a study of the general inclination of the Dakota rock, the probability is that it is still lower at Bismarck. This bore is cased with 8-inch casing to 505 feet. Inside of this is a string of 900 feet of 6-inch. Below this the bore is 4½ inches in diameter. No flows coming to the surface were found.

Ellendale Well.—Located in Sec. 12, T. 129 N., R. 63 W., town of Ellendale, county of Dickey, State of North Dakota. Owned by town of Ellendale. Commenced December, 1885. Completed April 6, 1886. Depth 1,087 feet. Drilled by Gray Brothers. Cost, $4,440, or $4.05 per foot. Flow, 700 gallons per minute. Pressure, 115 pounds per square inch when flow is shut off. Temperature of water, 69 degrees. Elevation above sea level, 1,463 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil and yellow clay	25	25
Blue clay	85	110
Shale	925	1,035
Hard sandstone cap	7	1,042
Soft sandstone (flow)	45	1,087
Bottom in sand rock	....	....

This well was put down for municipal purposes and obtained a good flow and pressure for fire protection and for the supply of 800 people, besides having sufficient water for irrigating lawns and a thirty-acre market garden. When the flow is shut off the pressure rises quickly to 80 pounds and in a few hours it reaches its maximum, 115 pounds. The temperature of the water is above the average in the Dakota basin. The water is soft and contains a little soda and magnesia. The well is cased with 1,037 feet of 4⅝-inch casing and 75 feet of 3¾-inch, with a lap of 25 feet. The lower end of 3¾-inch is perforated with ¾-inch holes, 12 to the foot.

Jones Well.—Located in Sec. 10, T. 129 N., R. 63 W., town two miles west of Ellendale, county of Dickey, State of North Dakota. Owned by W. H. Jones. Commenced April 6, 1891. Drilled by A. T. Hayman.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil, sand and clay	100	100
Gray shale	400	500
White clay and lime	32	532
Iron pyrites and lime	1	533
Sandstone (soft water rose 515 feet)	2	535
Clay Marl	65	600
Shale	18	....

This bore was abandoned at 618 feet on account of getting the drilling tools fastened.

Oakes Well.—Located in town of Oakes, county of Dickey, State of North Dakota. Owned by city of Oakes. Completed March, 1890. Drilled by Swan Brothers. Depth, 977 feet. Flow, 817 gallons when not clogged. Pressure, 125 pounds per square inch when flow is shut off. Temperature of well, 62 degrees. Elevation above sea level, 1,319 feet.

The strata passed through were as follows:

	Thickness in Feet.	Total in Feet.
Sand and gravel	65	65
Boulder clay	15	80
Blue clay	65	145
Blue shale	155	300
Hard streak lime	1	301
Blue shale	99	400
Hard streak lime	2	402
Blue shale	128	530
Shale and hard steak line	45	575
Black shale	125	700
Blue shale	20	720
Sand shale	25	745
Sticky shale	50	795
Sand shale	20	817
Sticky shale	35	850
Sand rock (hard)	5	855
Brown shale and sand rock	20	850
Lime and iron pyrites in streaks	5	885
White sand rock, streaks, lime and shale	62	942
White sand	10	952
Streaks, lime and sand	25	977

Mandan Well.—Located in Sec. 27, T. 139 N., R. 81 W., town of Mandan, county of Morton, State of North Dakota. Owned by city of Mandan. Commenced June, 1890. Drilled by Gray Brothers, Milwaukee, Wis. Elevation above sea level, 1,645 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
River desosit (sand)	90	90
River deposit (gravel)	5	95
Gray shale	25	120
Sand rock (small flow	5	125
Gray shale	285	410
Close sand rock (flow)	60	470
Shale, changing some in color but not in hardness; mixed badly	1,030	1,500
White marl (harder than shale, but no grit)	....	....

This bore is being put down by the city of Mandan, who have made contract to put down 2,000 feet. Cost when finished $10,000. December 12 the depth was 1,590 feet and drilling in shale. It is cased with 10-inch casing to 180 feet; then with 8-inch to 450 feet; then with 6-inch to 950 feet; then with 5-inch to the bottom, 1,590 feet. All the casings come to the top.

Hamilton Well.—Located in Sec. 35, T. 162 N., R. 53 W., town of Hamilton, county of Pembina, State of North Dakota. Owned by Hamilton Artesian Well company. Commenced November, 1887. Completed August 1889. Drilled by W. B. Clements, Cavalier, N. D. Depth, 1,560 feet. Cost, $10,150, or $6.50 per foot. Flow, twenty-six gallons per minute. Pressure, twenty-seven pounds per square inch when flow is shut off. Temperature of water, 41½ degrees. Elevation above sea level, 824 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil	10	10
Blue clay	122	132
Coarse sand (surface water)	42	174
Hard pan (cemented gravel)	15	189
Quicksand	4	193
Red shale	32	225
Blue shale	20	245
Red shale	43	288
Gray limestone	12	300
Blue shale (flow)	7	307
Gray limestone	277	584
Pink limestone	25	609
Gray limestone (very soft)	153	762
Blue shale (caving)	130	892
White sandstone	5	897
Blue granite	344	1,241
White sand (main flow)	1½	1,242½
Blue granite	1½	1,214
White sandstone	315	1,560

This bore was put down for a test well, and with the hope of obtaining a supply of water for city purposes. Two small flows of salt water were struck, one at 300 feet, which flowed eighty gallons per minute, the other at 1,241, which flowed at first forty-five gallons of brine per minute. The discharge is now twenty-six gallons per minute through 300 feet of three-fourths inch pipe, with a pressure of twelve pounds to the square inch. The water contains 2,000 grains of salt per gallon. The bore is cased with six inch casing to 350 feet. Inside of this is a string of 897 feet of four inch, which starts from the top. There are 600 feet of drill holes, and a drill in the bottom of this bore. The lower is in what is supposed to be Laurentian granite. The bottom of this bore is 736 below the level of the sea.

Devils Lake well.—Located in Sec. 34, T. 154 N., R. 64 W., town of Devils Lake, county of Ramsey, State of North Dakota. Owned by the city of Devils Lake. Commenced July 1888; completed July, 1889. Drilled by Swan Bros., Andover, S. D. Depth, 1,520 feet. Cost, $9,000, or $6 per foot. Flow, eighty-two gallons per minute. Pressure, twenty pounds per square inch when flow is shut off. Temperature of water, 62 degrees. Elevation above sea level, 1,473 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soft shale and soapstone	1,010	1,010
Hard gravel and sand	2	1,012
Black sandy shale (hard streak)	388	1,400
Black sandy shale (streaks sand)	28	1,428
Iron pyrites	3	1,431
Loose sand rock (water)	89	1,520

This bore was made for obtaining water for municipal purposes. The lower eighty-nine feet is in a very soft light-colored sand, which can hardly be called a rock, it being so soft as to cave in, while the bore was being made, so rapidly as to make further progress in drilling almost impossible. It is reported that for a short time an immense flow of sand and water came up with tremendous force, but after a little it suddenly dropped down to about eighty gallons per minute with a closed pressure of twenty pounds per square inch. During the first year considerable clean, sharp, whitish sand came up with the water. During the last year the sand has greatly disappeared, and the flow has increased three gallons per minute. The water flows into a tank for public use. The well is cased with eight inch casing to 158 feet. Inside of this is a string of 650 feet of six inch, which starts from the top; inside of the six inch casing is a string of four and one-half inch

792 feet in length. At the lower end of this is twenty-two feet of three and one-half inch, which is seated in hard sand rock. Then inside of this is 1,500 feet of three inch, which reaches from the top to within twenty feet of the bottom of the bore. The lower end of this pipe is plugged, and the sides of the pipe are slitted with five or six slits each one foot long, which are probably not over one-fourth of an inch wide, and through which all the water must pass into the pipe. The plugging and slitting of the pipe was done with the pipe in its present position. This slitting was done to prevent sand getting into the pipe. There are indications (judging from the operations of this well while being bored) of a much larger flow and greater pressure than is exhibited by this well. The following is an analysis of the water, by Prof. James A. Dodge, of the University of Minnesota:

	Grains per United States Gallon.
Sulphate of sodium	94.62
Chloride of sodium	86.46
Carbonate of sodium	41.11
Carbonate of potassium	4.62
Carbonate of lithium	.67
Carbonate of calcium	1.56
Carbonate of magnesium	1.01
Carbonate of iron	.03
Silica	.56
Borates	Traces
Bromides	Traces
Organic matter	Traces
Total of dissolved solids	230.64

Gases, none, except carbonic acid gas in moderate quantity, holding in solution the carbonates of calcium, magnesium and iron; hardness of water, three and one-half degrees; reaction, alkaline; color, none; odor, none; taste, somewhat brackish.

Jamestown Well.—Located in Sec. 36, T. 140 N., R. 64 W., town of Jamestown, county of Stutsman, State of North Dakota. Owned by city of Jamestown. Commenced October, 1886. Completed April 4, 1887. Depth, 1,476 feet. Cost, $6,700, or $4.54 per foot. Flow, 460 gallons per minute. Pressure, 97 pounds per square inch when flow is shut off. Temperature of water, 76 degrees. Elevation above sea level, 1,391 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil, clay and gravel	120	120
Light shale	905	1,025
Blue shale (hard streaks from iron pyrites)	275	1,300
Sandy shale	85	1,385
Sand rock (small flow)	10	1,395
Shale and iron pyrites	55	1,450
Hard sand rock (cap)	8	1,458
Soft Sand rock (flow)	18	1,476

This bore was put down by the city of Jamestown for municipal purposes. The pressure reaches its maximum instantly when the flow is shut off. This well is cased with five different sized casings, as follows: 570 feet of six and one-quarter inch; 497 of five and three-sixteenth inch; 400 feet of four and one-half inch; 105 feet of three and three-quarter inch. The latter has a lap of four feet; all the others lap forty feet. The three and one-half inch casing is perforated with one-half inch holes sixteen to the foot. The bottom of this bore penetrates eighteen feet into a soft sand rock and is eighty-five feet below sea level. Considerable gas was found while making the bore, which came up with the water in such quantity as to support a flame several feet high at the top of the casing. Probably it would still continue to come up if the well was allowed to flow without pressure.

Asylum well.—Located in Sec. 8, T. 139 N., R. 63 W., three miles southeast of Jamestown, county of Stutsman, State of North Dakota. Owned by the State of North Dakota. Commenced summer, 1889. Completed November, 1890. Drilled by Gray Bros., Milwaukee, Wis. Depth, 1,524 feet. Cost, $7,000, or $4 per foot. Flow, about four gallons per minute. Pressure, 70 pounds when flow is shut off. Elevation above sea level, 1,470 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil	2	2
Red Clay	40	42
Fire Clay (not pure)	49	91
Quicksand and limestone bowlder (some lignite)	20	111
Shale, with limestone gravel	110	211
Light-colored shale	150	361
Dark-colored shale	200	561
Light and dark shale, streaks limestone	389	959
Sandy shale	40	999
Sand	10	1,009
Blue shale (hard streaks limestone)	290	1,299

	Thickness in Feet.	Total in Feet.
Quicksand, streaks, shale and limestone	175	1,474
Hard sand rock	7	1,481
Soft sand rock (water)	3	1,484
Hard sand rock, iron pyrites	10	1,494
Soft sand rock (water)	11	1,505
Solid limestone	19	1,524

This bore was put down by the State of North Dakota for water for the use of the State insane asylum. The flow was at first about 200 gallons per minute. The soft sand rock found at 1,494 feet is caving in, and on July 8 the bottom of the bore had been filled up 40 feet with sand. The well is cased as follows: 900 feet of 8-inch, 550 feet of 5-inch, which laps 150 feet on the 8-inch; 250 feet of 4-inch, which laps 100 feet on the 5-inch; 100 feet of 3½-inch, which laps 50 feet on the 4-inch. The lower end of the 3½-inch is open, with no perforations. The bottom of this bore is 19 feet into a solid lime rock. This rock does not appear in the city well, about two miles distant. The lower end of the bore is 54 feet below sea level, or 31 feet above the bottom of the city well. At 1,200 feet a bed of mussel shells was passed through. The following is an analysis of the water by Erastus G. Smith, professor of chemistry, Beloit College:

Name of Compound.	Symbol.	Grains per United States Gallon (231 Cubic Inches.)
Sodium sulphate	Na_2SO_4	93.85
Sodium chloride	$NaCl$	21.34
Sodium phosphate	Na_3PO_4	Trace.
Magnesium chloride	$MgCl_2$	1.24
Magnesia carbonate	$MgCO_3$	2.98
Calcium carbonate	$CaCO_3$	8.44
Alumina	Al_2O_3	.21
Iron oxide	Fe_2O_3	.12
Silica	S_1O_2	.64
Total		128.82

From the above analysis it appears that the markedly saline taste of the water is due to:

Sodium sulphate.
Sodium chloride.
Magnesium chloride.

The water will produce, probably, marked laxative effects, especially to those not accustomed to its use. I should hesitate to use it as a boiler water, unless no other is to be had; and even then care should be used in selecting a proper scale compound. The water is quite free from organic matter.

Grafton Well.—Located in Sec. 13, T. 147 N., R. 53 W., town of Grafton, county of Walsh, State of North Dakota. Owned by town of Grafton. Commenced February 24, 1885. Completed June 20, 1885. Drilled by Swan Bros., Andover, S. D. Depth, 912 feet; cost $3,800, or $4.16 per foot; flow, 600 gallons per minute; pressure, 12 pounds per square inch when flow is shut off; temperature of water, 46 degrees; elevation above sea level, 825 feet.

The strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Soil	3	3
Yellow clay	10	13
Blue clay	90	103
Gravelly clay (blue)	30	133
Quicksand (clayey)	22	155
Hardpan	40	195
Sand and gravel (white, light flow)	30	225
Sand (coarse white)	20	245
Red shale rock	10	255
Lime rock (reddish)	2	257
Red shale	13	270
White sand rock (flow of water)	60	330
Blue shale	3	333
Red shale	3	336
Lime rock (gray)	4	340
Red shale and lime streaks	48	388
Green shale (brine flow)	2	390
Gray lime-rock (gritty)	5	395
Magnesian lime-rock	200	595
Cream colored lime-rock	105	700
Red shale and lime-rock	45	745
Blue shale	145	880
Red shale (gritty)	20	900
Sand and quartz (white)	3	903
Granite (Gray)	9	912

This well was put down for municipal purposes. The water being salty, is not suitable for domestic use, although used for watering stock and for fire purposes, and for sprinkling streets. No flows were found below 390 feet, and the bore was purposely filled up to this point. When allowed to flow freely, considerable sand is thrown up. The water contains 240 grains of salt per gallon, with a small amount of Epsom salts. The well is cased with 160 feet of 8-inch casing and 200 feet of 6-inch. The latter starts from the top and is seated in the sand-rock 100 feet above the lower flow. The lower end of the bore penetrates nine feet into gray granite. Just above this is a 3-foot stratum of sand and quartz rock. It will be observed that all the salt water wells have a low temperature.

Moorhead Well.—Located in Sec. 8, T. 139 N., R. 48 W., town of Moorhead, county of Clay, State of Minnesota. Owned by city of Moorhead. Commenced February 23, 1888. Completed October 21, 1889. Drilled by Gray Brothers, Jamestown, N. D. Depth, 1,901 feet. Cost, $10,000, or $5.26 per foot. Elevation above sea level, 901 feet.

Strata passed through are as follows:

	Thickness in feet.	Total in Feet.
Black soil	2	2
Yellow loam	3	5
Yellow clay	50	55
Brown clay (sticky, tough)	55	110
Hard gravel (water)	10	120
Coarser gravel (water nearly to surface)	15	135
Coarse gravel, sand and clay	60	195
Granite bowlder	5	200
Clay, with bowlders	29	220
Dark clay	20	240
Dark bluish clay	60	300
Quicksand (water)	70	370
Blue shale and quartz sand	105	475
Alternating layers blue, red, and grav rock; blue not hard, red harder, and gray very hard, changes every 30 or 40 feet	725	1,200
Quicksand, broken lignite	3	1,203
Soft sand-rock, light colored	27	1,230
Soapstone, strong fish odor	20	1,250
Coarse sand-rock	10	1,260
Hard sand-rock	40	1,300
Iron pyrites and lime	1	1,301
Hard blue rock (Laurentian granite)	600	1,901

This bore is just across the Red river from Fargo. It was put down by the city of Moorhead for a test well, with the hope of obtaining a supply of domestic water for municipal purposes. The bottom of this bore is 1,000 feet below the level of the sea, and penetrates the granite 600 feet. The first vein of water, which was struck at 120 feet, came within three feet of the top of the bore. When the second flow was struck the water receded to 200 feet from the surface; when the third flow was struck at 950 feet, the water rises again within 50 feet of the surface. This bore is cased with 800 feet of 8-inch casing, and inside of this is 1,265 feet of 4½-inch, which starts from the top and is seated in hard sand-rock. Although it is not a flowing well, all the water found is artesian, but of a negative character.

Chinook Well.—Town of Chinook, county of Choteau, State of Montana. Owned by Chinook Artesian Company. Commenced July, 1890. Drilled by hired employes. Depth, 960 feet; cost, $4,490, or $4.70 per foot. Temperature of water, 40 degrees. Elevation above sea level, 2,404 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Loam and sand	112	112
Stone bowlders	12	124
Stiff clay	96	220
Sandstone	2	222
Blue clay	318	540
Sandstone	1½	541½
Blue clay	78½	620
Blue clay, interspersed with thin strata lime and sandstone, soft mud	330	950
Blue clay, with gas and petroleum	6	956

This bore was put down to its present depth by the town of Chinook, Mont. Owing to some uncertainty regarding the title and ownership of the land on which the work was being made, work has been suspended until the title can be perfected. Data relative to this bore was obtained by correspondence, which states that four flows were struck at 112, 220, 540 and 620 feet. The supposition is that at these depths are veins of water which are probably artesian in their character, but not of sufficient force to flow over the top of the bore. The two lower veins are reported to be salty.

Beck Well.—Located in Sec. 34, T. 8 S., R. 47 E., town of Miles City, county of Custer. state of Montana. Owned by O. C. Beck. Commenced June, 1886. Completed June, 1886. Drilled by O. C. Beck. Depth, 456 feet; cost, $575, or $1.25 per foot. Flow, 5 gallons per minute. Pressure, 7 pounds per square inch when flow is shut off. Temperature of water, 57 degrees. Elevation above sea level, 2,353 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Adobe soil and subsoil	19	19
Gravel	21	40
Hard sand-rock	2	42
Hard slate or soapstone	18	60
Sand-rock (water, not flow)	5	65
Slate and rock (mixed)	185	250
Sand-rock (two light flows)	50	300
Shale	93	393
Sand-rock (main flow). Bottom on sand-rock	63	456

This bore is one of about thirty that have been put down in the vicinity of Miles City, Mont. The volume discharged, strata passed through and quality of the water of this well are a fair representation of those of others in this basin, which we denominate the Miles City basin. The receiving area for a subterranean or artesian water supply that may lie in this valley is amply large and sufficiently elevated to give the requisite pressure and volume. It is not at all unlikely that this basin extends far up and down the valley of the Yellowstone, far beyond the country yet developed. The existence of the other necessary conditions for an artesian supply are matters for the geologist to predict and the drill of the prospector to determine.

Rosenfeld Junction well.—Located in T. 166 N., R. 54 W., town of Rosenfeld Junction, province of Manitoba. Owned by Canadian Pacific railroad. Drilled by Swan Company. Depth, 1,037 feet. Elevation above sea level, 780 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Black soil	4	4
Blue clay	111	115
Sand and gravel	10	125
Bowlder clay (hardpan)	12	137
Bowlders	6	143
Gray shale	62	205
Limestone	15	220
Red shale	5	222
Gray shale	10	235
Limestone	30	265
Fine Gray sandstone (small flow brine)	40	305
Chalky limestone	30	335
Red shale	160	495
Cream colored limestone (Galena limestone passing above Trenton)	305	800
Red Shale	75	875
Soft sandstone (brine flow), St. Peter	50	925
Dark red shale	50	975
Reddish and green shale	25	1,000
Bluish and gray shale	20	1,020
Red shale	15	1,035
Laurentian granite	2	1,037

Reference to this bore is made for the value of its log, which appears to have been carefully kept. The two small flows obtained were both salty; recorded as being dry. Granite was struck at 1,037 feet. Location in this bore is given by projecting the United States land surveys.

Deloraine City well.—Manitoba. Owned by the city and government. Commenced in 1887. Depth, 1,800 feet. Elevation above sea level, 1,620 feet.

Strata passed through are as follows:

	Thickness in Feet.	Total in Feet.
Black surface soil	3	3
Clay loam, with gravel and pebbles	30	33
Hardpan, with blue clay	56	89
Fine sand	5	94
Shale and slate, with layers of sand	198	292
Soapstone, with streaks of limestone	495	787
Blue clay, with snail shells	188	975
Slate (soft), soapstone and mud	825	1,800

This bore is noticed on account of its location. It is about ten miles beyond the boundary line in Canada, and is located about sixty miles west of an axial line through the developed section of the Dakota artesian basin. The sinking of the bore was first undertaken by the town of Deloraine for municipal purposes. The town authorities were induced to believe they would strike the artesian flow at at about the same level as the nearest well in the United States, which is at Devils Lake. To do this would require a bore about 1,578 feet deep. This depth was reached and no water found. The work was stopped until the Dominion Government came to the relief of the town, and for the further purpose of making a test exploration of the rock strata. It is intended to continue to sink the bore until the water-bearing strata is reached, provided it lies within a reasonable distance. Its depth on August, 1891, was 1,800 feet or 180 feet below sea level, or 133 feet lower than the bottom of the bore at Devils Lake. This well is now flowing, giving large volumes of water. The obtaining of water at this point is a *discovery of much importance*, as it seems to clearly indicate the Dakota Artesian Basin extends through the entire length of North Dakota, and beyond into Manitoba.

THE RED RIVER VALLEY ARTESIAN BASIN.

No more condensed description of this basin can be made, and give all the minute details, than the report of Engineer W. W. Hollett, connected with the Irrigation and Underflow Investigation of 1891, and as it is a subject of great importance, I present much of the same. Mr. Hollett says:

The territory covered by this report is about 150 miles long, north and south, by about 35 miles wide, east and west. That portion of it in which artesian water is found lies along the river and back from it for 12 or 15 miles—in some places 20 miles—

and is of very uniform surface, falling in the 150 miles from 903 feet above sea level at Fargo to about 810 feet at Pembina, or only some 0.6 per mile. The fall from west to east is from 5 to 10 feet to the mile, being less near the river and greater farther back. West of the valley proper the ground rises much more rapidly, being the southern continuation of that ridge which terminates at the north in the Pembina mountains. The basin extends across the river into Minnesota for a short distance. I did not go into this territory, as it is outside the limits of this investigation, but learned by inquiry that there were some wells all along the river in Minnesota, and that the quality of the water was bad near the river. At Crookston, about eighteen miles east of the river, I was told there were 18 or 20 flowing wells of good water. I could learn nothing of their depth, size, pressure, or flow. They may be in this basin and they may be in another.

The main and lower artesian vein in this valley lies at a depth of between 200 and 300 feet below the surface and is in a drift formation. The water is found in a clean white sand or sandstone. Mr. Swan, who drilled the well at Grafton, and also one at Rosenfeld Junction, in Manitoba, about 15 miles north of the boundary line, calls it "gray sandstone." The shoal-well drillers call it sand. It is quite likely that it is an open, porous sandstone, very friable, and containing much free sand. If it were loose sand only it would be impossible to keep a hole open in it. The drillers do, however, except in a few cases where the flow is very free when first struck, go down in it as far as they wish and put in their pipe, using no screen on the lower end of the pipe.

This sandstone is immediately overlaid by red shale or cemented gravel. The upper formations are quicksand, some limestone in places, shale, clay with granite boulders, and clay. The water is salty. The amount of salt is small at the south and increases to the north. I could not determine to my satisfaction that there was any increase in the amount of salt in the water as the river was approached or as lower ground was reached. At Grafton it was thought by some that this was the case, but no one was sure of it.

The surface pressure of the water, on east and west lines, was, in Walsh county at least, about the same so long as the rise of the ground was not over five feet per mile. When the rise became more rapid the pressure grew less, until the water will not come to the surface.

There is above this main vein two or three weak veins, from 100 to 200 or 250 feet below the surface. These veins are not continuous. In fact, if the quality of the water in adjacent wells is any criterion, it may be best to say that there are two or three sets of veins above the main flow. One well, say 150 feet deep, may flow water so bitter and impregnated with minerals that no animal can drink it, while a well near by, of about the same depth, flows good water, fit for domestic use. These upper veins are also very much broken up. In places the wells going to the deep or main flow will strike two or three weak flows above it. In others none will be struck, Perhaps a hole will be put down 200 feet, a granite boulder struck, and the hole abandoned with no water, the rig moved 50 or 75 feet away and a flow obtained at 100 or 150 feet.

These upper veins are in quicksand, under clay or boulder clay. The veins are generally thin, not more than two to five feet of sand, although in places 25 to 30 feet of quicksand is encountered. They have only two to five pounds pressure and a small flow, seldom exceeding five gallons per minute. The water varies widely in quality, but is generally bitter and impregnated with minerals.

Beginning at the north and taking the several counties in order, the following is a history of the wells, as near as could be learned without a personal visit to each well:

Pembina County.—This county includes the first 32 miles south of the international boundary.

At Hamilton, about the center of the county, a 4½-inch well (see Hamilton well in the main report on the Dakota wells) was put down to a depth of 1,560 feet. In this hole a vein of salt water, not flowing, was struck at 174 feet; a flowing vein, furnishing 80 gallons per minute, at 300 feet and another furnishing 125 gallons per minute of brine at 1,241 feet in a rift in the granite. This last flow contains 3½ per cent of salt, or 2,000 grains per gallon. The flow at 300 feet contains about 350 to 410 grains per gallon, but was bitter, as was that struck at 174 feet. The water from the deep vein (the others were cased off) kills vegetation and is used only for bathing. Its temperature is 41½ degrees Fahrenheit and the pressure when closed is 27 pounds. The well is not in such shape that the flow can be measured. The 4½ inch pipe is plugged with a long wooden plug having a ¾-inch gas pipe through it with a T on top. One end of the T runs to a bath tub, and the other end has a valve on and opens to the air. This valve will pass 26 gallons per minute with the gauge on the other end of the T reading 12 pounds pressure. It is impossible to say what portion of the full flow of the well this may be.

At the elevator in Hamilton is a 2-inch well 290 feet deep, with small flow, not used. There are ten or twelve 2-inch wells down 175 to 200 feet around in the country near Hamilton. They all have small flows and are used for stock water. At Bathgate, six miles north of Hamilton, there is a small well.

St. Thomas, four miles north of the south boundary of the county, has three or four 2-inch wells with very weak flows.

These are all the wells I could hear of in Pembina county.

They show that the artesian veins, while underlying the country, are poorly supplied with water. Attempts for wells at various places show that the veins are broken up, pinching entirely out in places. This is especially true along near the Red river. Hamilton lies back 11 miles from it.

Walsh County.—The next county south of Pembina is Walsh. It is 24 miles wide, north and south, and has the best wells in this valley. The number of flowing wells in this valley is about as follows:

Six-inch well going to deep vein	1
Three-inch wells going to deep vein	2
Two-inch wells going to deep vein (about)	20
Two-inch wells going to upper veins (about)	60
Total	83

The depth of wells going to the deep or main flow varies from 220 feet up to 300 feet. This flow is always overlaid by cemented gravel and boulders or red shale, and is a coarser sand than the upper flows.

Grafton, the county seat, eight miles south of the county's northern boundary, seems to be the center of the area giving free and large flows. The city has a six-inch deep well (see "Grafton Well" in main report on Dakota wells) put down to a depth of 912 feet. It is plugged up below 330 feet and derives its water from a white sand or sand rock lying under red shale between 270 and 330 feet. It was supposed in Grafton that the flow came from below 500 feet. One log gave it as from 503 to 523 and another as from 511 to 536. The temperature, pressure and quality of water all led me to believe that the flow was from the same vein as that of the two-inch and three-inch wells in the neighborhood. I wrote to Mr. A. E. Swan, who put the well down, and he told me that the well was plugged below 330 feet, as stated above, and that no water at all was found below 330 feet, except a flow of brine at 390 feet. The well flows 600 gallons per minute. Temperature 46 degrees F. Pressure, 12 pounds, and has 240 grains of salt to one gallon of water.

There are two three-inch wells in this county. The one at the court house in Grafton is 301 feet deep. Water was struck in sand rock under red shale at 281 feet and has a pressure of 12 pounds; temperature, 45 degrees; and flow, 175 gallons per minute. The flow of this well was obtained with considerable difficulty, as a valve had to be taken to pieces and taken off, some reducers taken out and a piece of pipe put on to carry the water outside the well house. The flow of 175 gallons was a Weir measurement of the full flow of the well.

The other three-inch well is at Minto, eight miles south and three miles east of Grafton. The water was struck in friable sand rock, under cemented gravel, at a depth of 209 feet, and the well is said to have a flow of 175 gallons per minute and a pressure of 12 pounds. The quality of water is same as at Grafton.

A sample of the two-inch wells going down to this flow gave temperature and pressure and flow of 45 gallons per minute. It was flowing some sand, and I was told that some of the other two-inch wells flowed more water, probably 60 gallons per minute.

These samples show that the flow here is abundant. The sand, or sand rock, is 60 feet thick and so free that the water gets through it readily.

Over on Red river, about ten miles southeast of Grafton, are two two-inch wells reaching this vein. They are 227 feet deep; water is in sand or friable sandstone, under cemented gravel; 12 pounds pressure and 30 gallons per minute flow, with about 300 grains of salt per gallon. In one of them a small flow was struck in quicksand at 120 feet, but none in the other at that depth, although the two wells are only about half a mile apart.

The other two-inch wells are near Grafton and west of there. Those farthest away are ten miles west of Grafton, or twenty miles from the river. The pressure and flow are less on these than at Grafton, but the water is said to be a little less saline.

I was told in Grafton that the water of this main flow contains more salt as it is tapped further east and is quite strongly saline where struck in Minnesota, across the river.

The shoal wells are scattered all over the eastern eighteen miles of the county. They are from 100 to 150 feet deep and are all two-inch wells. The water is found in quicksand, under clay. The pressure is only 2 to 4 pounds, and the flow very small, ranging from 1 to 5 gallons per minute. The quality of the water varies widely; some of it is good for household use and some is bitter and salty.

Attempts have been made for wells in the central part of the county, but have been unsuccessful. At Park River, elevation 993 feet, a well has been put down 492 feet. The clays which underlie the upper veins of water around Grafton here come to the surface. At 98 feet, five feet of sand was struck, with a vein of water which came within 30 feet of the surface. This is probably the main vein of the lower valley. A smaller supply, under less pressure, was struck in two feet of sand rock at 300 feet, but no water below this.

Grand Forks County—This county is 36 miles wide, north and south. There are very few flowing wells in the county. The number is about as follows:

About six miles southeast of Forest River, in the north edge of the county, 2-inch wells	3
Three miles west of the river, 2-inch wells	10
At Ojata, twelve miles west of the river and twenty miles south of the northern boundary, 2-inch wells	2
At Reynolds, on south boundary of county, 3-inch well	1
Total, one 3-inch, fifteen 2-inch wells	16

The most of these go down to the lower or main flow. Around Manvel many wells have been put down to an upper flow, struck at about 100 feet in quicksand. These are of no account, as they invariably soon choke up with sand and stop flowing.

One of the three wells six miles southeast of Forest River is said to be 125 feet deep and flows fresh water. The other two are 160 feet and 230 feet deep, respectively, close to the first, and both flow salt water. I did not visit these wells.

At Manvel I examined a two-inch well 166 feet deep that gave about ten pounds pressure, 60 gallons per minute flow, temperature 46 degrees, water salty and bitter, but used for stock. It is too strong for household use. The owner of the well, and others said that quicksand and first flow was struck at about 95 feet, and that there was no hard material below this point, but that the sand gradually got coarser until the main flow was struck in coarse gravel at 165 feet. This, while contrary to what one would naturally expect, is probably correct, and the water struck at 95 feet is from the main flow, but impeded by the quicksand. This well was a new one put down about two moths ago, and has the largest flow of any of the wells at Manvel. The average of the ten in and around Manvel would be about 25 gallons per minute. In all the water is too rank for household use, but stock drink it readily. They are from 125 to 175 feet deep. The vein seems to be pinched out all around Manvel, as none of the wells obtained are more than three miles away, and outside of that limit several dry holes have been put down. Six miles southwest of Manvel, on Turtle river, a hole was put down 300 feet, and no water obtained.

I was told there were at Ojata two two-inch wells flowing a small amount of water. My time was so limited I did not visit them.

At Reynolds the three-inch well is 218 feet deep and flows about four gallons per minute; water salty, not so strong but that it can be used for household purposes.

In the western part of the county several dry holes have been put down. Near Larimore three holes have reached a depth of about 600 feet and no water. At Northwood, four miles north of south boundary of the county, and 30 miles west of the river, a hole is now being put down. They are down some 300 feet and have no water. About three miles south of the north boundary of county and twenty-two miles west of the river a hole was put down 200 feet and no water obtained. There are samples of quite a number of fruitless attempts for water in the western part of Grand Forks county.

I could not learn that abortive attempts for wells had been made at or near Grand Forks, but it is fair to suppose such is the case, as there are no flowing wells in that part of the county.

There are possibly a few in small wells in the southeast corner of the county.

Traill County—Traill county is thirty miles wide, north and south, and extends the same distance west from the river. There are a large number of flowing wells in the county, pretty generally scattered over it, except in the extreme western edge. It is difficult to give the number in the county without a detailed examination and visit to each township. The following is approximately the number:

Location of Wells	Size in Inches.	No.
Buxton	3	1
In and near Buxton	2	15
In and near Hillsboro	2	70
In and near Caledonia and along river	2	60
In and near Kelso	2	10
Mayville	6	1
In and near Mayville	2	10
Portland	7	1
Along railroad, south and southeast of Mayville	2	15
Total	....	183

It is currently reported that there are 400 flowing wells in Traill county. This would give nearly one well to each section throughout the portion of the county where wells are obtained, and it is certain there are not that many. The number might go up to 250 by counting all the weak flowing wells and those which have flowed at one time, but have now failed. The number cannot go beyond 250.

In the eastern half of the county the wells run from 125 to 175 feet deep, except a few deep wells which are from 250 to 300 feet deep. The flow of the shoal wells is small, probably averaging five gallons per minute. The quality of the water is rather poor. All of it is saline and all of it has other mineral in it, rendering it bitter and, in many cases, unfit for household use. The quality of the water near the river is said to be better than that farther west. The temperature of all is 46 degrees and the pressure about ten pounds, varying, however, from seven pounds along the river to twenty pounds in some of the shoal wells at Hillsboro, near the center of the county. The water is generally found in gravel under blue clay; sometimes quicksand is encountered, but the flow, if any is obtained, is small and of poor quality.

As in Grand Forks county, the water-bearing strata seems to be much broken up. In Hillsboro are some ten wells, all flowing, yet a dry hole was put down 715 feet at the elevator, the last 115 feet in Laurentian granite, and two or three other dry holes were had in different parts of the town. From all parts of the county failures are reported.

North of Hillsboro are four deep wells. One of them is 262 feet deep. No water was struck until 259 feet was reached. Then water in gravel under blue clay, flowing 67 gallons per minute; temperature 46 degrees, pressure about thirty pounds; water saline but good for stock and household. The other deep wells are similar both in material passed through, flow and pressure, although their flow is smaller than that of this well.

All the wells around Buxton, in the northern part of the county, are said to be between 300 and 400 feet deep, and to flow from eight to ten gallons per minute. It is likely these depths are too great, but it may not be. I did not have time to visit Buxton.

The wells around Kelso, near the south side of the county, are from 110 to 125 feet deep, and have a very light flow, not over two or three gallons per minute.

In the extreme south edge of the county, and ten miles west of the river, is a four and a half inch well recently put down to the depth of 306 feet. There was an old two-inch well on the place 206 feet deep, with a very small flow, and this one was put down to obtain, if possible, a larger flow. At 305 feet a vein of sand and gravel one foot thick was struck, which furnished at first a little water, coming up in the pipe to within 21 feet of the surface. The pump was put in to try the volume of water which could be pumped. Sand commenced to run and the water pressure to increase until in 48 hours the well was flowing 35 gallons per minute from a pipe four feet above the ground, and had a pressure of two pounds. The temperature was 46 degrees and the water is very hard, but slightly saline, and is good for household and stock. This is the only well I could learn of in the southern portion of Traill county which went down to this lower vein. It is doubtful whether or not the vein is continuous. As seen in the record of this well it was almost pinched out here.

The six-inch well at Mayville, near the western part of the county, is 357 feet deep. The strata passed through were clay and then rock-clay and gravel mixed with some cemented gravel. Two or three light flows of water were obtained from this vein of quicksand. The final flow is from sand, but is small. It could not be measured as it was attached to mains and a tank, but as near as could be learned from inquiry it was some 60 gallons per minute; temperature, 46 degrees; pressure, eight pounds; quality, salty, but used for household.

The two-inch wells around Mayville vary from 200 to 375 feet in depth, and have flows of 30 to 40 gallons per minute. All are saline, but used for stock and men.

The seven-inch well at Portland, three miles west of Mayville, is 560 feet deep. The strata passed through are clay, hard pan and rock-magnesian clay, quicksand hard pan, quicksand and then water in hard gravel. Two small flows were obtained from the quicksand strata. This well also could not be measured, as it was attached to a tank and mains. The flow is larger than that of the Mayville well. Some gave it as 275 gallons, but this is probably too high. It has at least 150 gallons per minute flow, pressure 8 pounds, temperature 46 degrees, quality saline, but good for household use. It supplies 300 people. There are no other flowing wells in Portland.

About 8 miles southwest of Mayville is a two-inch well 440 feet deep. There was a light flow struck in quicksand at 375 feet. The main flow is in sand under hard pan, flow 30 gallons per minute, pressure about 10 pounds, temperature 46 degrees, good water, only slightly saline. The well has the largest flow of any south of Mayville.

Near Blanchard, 8 miles north of the south line of the county, are some 8 or ten wells from 150 to 350 feet deep and all having fair flows, probably 10 or 15 gallons per minute, all good water.

The formation in the western part of the county is considerably different from that in the eastern part. The different veins of water become more widely separated and the intervening material becomes harder and more stony. It is called by the well men "a hard country to drill in."

Cass County.—Cass is a large county, being 42 miles wide north and south, and extending 42 miles west from Red river. The portion, however, which lies in this basin, is in the northeastern part and north of Fargo, and is 25 miles wide, north and south, and extends 20 miles west from the river. There are some 10 or 12 wells in the southwestern part of the county, but they are probably in a separate artesian basin (the "Tower City" basin), and should be treated in a separate report.

The number of flowing wells in the northeastern part of the county is about as follows:

Location of Wells.	Size in Inches.	No.
Grandin and the two townships at north side of county	2	50
Gardiner and the two townships next south	2	35
Argusville and near there	2	15
Hunter and east	2	25
North of Casselton, along railroad	2	10
Total		135

It is currently stated that there are "several hundred" flowing wells in this county, but I could not materialize them. The number given above is about correct, barring the few in the southwestern part of the county, which, owing to their depth, flow, pressure and quality of water, are thought to be in another artesian basin.

All of these 135 wells stop at the first flow obtained. Whether there is a deeper flow at all places or not, I am not prepared to say, but it is doubtful. In a few places holes have been put down 300 to 400 feet without getting water. The wells vary in depth from about 200 feet in and around Grandin to about 120 feet in Gardiner. When at Grandin I could learn of but one well, the four and one-half inch well in the extreme south edge of Traill county, which went down to the lower flow. At Fargo and at Mayville, it was reported that there were several between Grandin and the river which went down to it, but diligent inquiry failed to find them.

The flows of these wells are all small; probably two gallons per minute would be about the average. The pressure on all is light, not over two pounds in any, and in some decreasing to barely enough to cause the water to flow. The water is all saline, none of it is pure and none of it very bad. The drilling in the eastern part is easy and wells fairly sure, except close to the river. There many dry holes have been put down. In the western part, along, near and east of the railroad running north from Casselton, the drilling is much harder, as much gravel and boulder clay is encountered. The wells are deeper than near Grandin and Gardiner, but the flow is stronger. At Hunter is a two-inch well belonging to the town, 345 feet deep, flow about 15 gallons per minute, pressure eight pounds, water clear and good. The other wells near Hunter are deep, nearly all reaching 300 feet, and the average flow would probably be six or eight gallons per minute.

Around Argusville the flow is small and the pressure is almost nothing. One two-inch well at Harwood, eight miles northwest of Fargo, barely flows.

In Fargo no flowing wells are obtained unless in depressions. This same vein underlies the whole country here, however, at a depth of from 160 feet to 180 feet, the water rising to within a few feet of the surface and being slightly saline.

The total number of wells and aggregate flow in this basin are as follows:

County.	1-inch.	6-inch.	4½inch	3-inch.	2-inch.	Aggregate Flow. Gallons
Pembina			1		17	165
Walsh		1		2	80	1,950
Grand Forks				1	15	370
Traill	1	1	1	1	180	1,800
Cass					135	300
Total	1	2	2	4	427	4,585

This total of 4,585 gallons per minute means 20 acre feet per day, or 7,300 acre feet per year. As much of the flow is estimated, it may be possible that the whole flow of the wells is 10,000 acre feet per year from an artesian vein that is known to be 125 miles long by at least 25 miles wide, or an area of 1,875 square miles, or 1,200,000 acres. This 10,000 acre feet spread over this area would be one-tenth of an inch deep. In other words, the combined flow of all the wells, provided they ran constantly, would only lower the water in the sand rock one-tenth of an inch if it were a continuous sheet of water. The fact is that the wells do not average flowing more than half the time. It is needless to say that the supply is not visibly decreasing except in a few wells that are in quicksand where the water does not have free access to the pipe.

FORMATIONS.

While it is the province of our geologists to discuss the stratigraphy of the country, it seems best in this connection to give, as a matter of record, the notes which I obtained of the formation in the valley.

The Archæan rock underlying the valley is a gray rock called by the Canadian geologist "Laurentian granite." It is claimed by some that this is not granite, but a very hard impure sandstone. Whatever it is, its presence is constant under the valley wherever holes have been put down deep enough to reach it.

Location.	Elevation in Feet.	Was Struck at About—Feet.	Sea Level. Feet.
Moorhead	903	550	353
Hillsboro	901	600	301
Grafton	827	903	—76
Hamilton	824	897	—73
Rosenfeld Junction	780	1,035	—255
Winnipeg	750	1,000	—250

It is stated that the granite is below the surface. This shows an average dip to the north of three feet to the mile, about five times the dip of the present surface,

With the exception of the well at Hamilton, no flowing water is found in this rock, although it was penetrated some 1,250 feet at Moorhead, 115 feet at Hillsboro and 650 feet at Hamilton, At Grafton and at Rosenfeld Junction work stopped when the granite was reached. The rock at Moorhead and at Hillsboro seems to lie level, but at Hamilton the stratification is supposed to be tilted up on edge, as shown by the fact that the drill, when striking veins of mica, would go off one side of the hole, making a crooked hole. This may account for the fact that water is obtained in the rock there, or there may be vertical seams in the granite, reaching to the surface. The water at Hamilton is found in a sand vein 1½ feet thick, 1,241 feet below the surface of the ground, and 344 feet below the top of the rock. This, as stated above, may be simply a rift extending to the surface of the rock and drawing water from the artesian vein far above.

Overlying this rock is a thin stratum of sandstone not always present. It contains no water.

Above the sandstone is a deposit of shale of varying thickness. At Rosenfeld Junction it was 160 feet thick; at Hamilton, 130 feet; at Grafton, 200 feet; at Hillsboro, about 200 feet thick; at Moorhead, 105 feet thick. This shale all contains sand. At Rosenfeld Junction the upper 50 feet was so sandy that it was classed as "sandstone."

On top of the shale comes limestone of varying degrees of hardness and of varying thickness. At Rosenfeld Junction it was 380 feet and furnished a flow of water 3½ per cent. salt at 300 feet below its upper surface. At Hamilton it was 455 feet thick; at Grafton, 310 feet; at Hillsboro, a little, and not present at Moorhead.

Above the limestone comes more shale of various colors and degrees of hardness. These shales vary in thickness, but come up to the sand or sandstone, which furnishes the main artesian flow. They are thickest to the north, being 350 feet thick at Rosenfeld Junction, and apparently coming so high up as to entirely pinch out the artesian sandstone, being there immediately overlaid with bowlder and bowlder clay, and coming within 145 feet of the surface. At Rosenfeld Junction, Hamilton and Grafton a light flow of brine was found in this shale, but of small pressure and amount.

The artesian sand, or sandstone, lies on top of this shale. It varies widely in thickness in different places, and is, as mentioned several times in this report, sometimes entirely wanting. At Rosenfeld Junction it is wanting. At Hamilton it is four feet thick, and seems to take the form of quicksand. At Grafton it is 60 feet thick. At Hillsboro it is thin, wanting in one hole. At Grandin it is only a foot thick, and seems to be gravel. At Moorhead it takes the form of quicksand, and is 70 feet thick. Along the western edge of the basin it varies widely in thickness, and seems to be in many cases sand or gravel.

The artesian sandstone is overlaid in nearly all cases by cemented gravel, or red shale, especially in the northern portion of the basin. At Hamilton it was overlaid by six feet of cemented gravel (locally called "hardpan;") at Grafton by 13 feet of red shale; at Hillsboro it was overlaid by clay; at Caledonia by red shale; at Moorhead by blue clay.

Above this cemented gravel or shale comes clay and bowlder clay. The bowlders are granite and very troublesome to drill. The weaker flows are found in veins of quicksand scattered through the clay. The thickness of these quicksand strata vary; frequently they are not present, and at times become 25 to 30 feet thick.

Above this bowlder clay comes blue clay without bowlders, then yellow clay, and then soil.

These are, in a general way, the strata found in the valley. Reference to the log of wells examined in this valley will show considerable variations from these given and, in a few cases, entirely different formations. These are, in general, true for that portion of the wells located on the flat country near the river.

About twenty miles west of the Red river is a strip of "clay country," three or four miles wide, running through all the counties covered by this report. At the international boundary it is 25 miles west of the river, and at Gardiner it is 15 miles. East of this clay strip it is very difficult to obtain "surface" wells, that is, shoal wells from which the water is pumped. In many places no water will be struck before the upper weak artesian veins are touched, and in others water will be found seeping in through the clay, but so bitter and impregnated with minerals that it is unfit for use. West of this ridge, however, the subsoil becomes more sandy, and sweet water is found in abundance at a depth of 15 to 20 feet. This is true for the next 10 or 15 miles west, or until the country begins to rise into the Pembina ridge. The elevation of this country is from 100 to 200 feet above the river east of it. It is quite likely that this sandy country supplies the upper or weak veins in the valley to the east. It is not exact to say that the clay strip is the cropping of the blue and yellow clays below the surface in the lower valley, as the clay is here as thick, or thicker, than east, but it is evidently the western terminus of these clays.

West of the sandy country and at about the eastern edge of the Pembina ridge is found the bowlder clay. Further west is a gravely country, and then a sandy country running into a clay underlaid by shale. For 10 or 12 miles southeast of Langdon, 15 miles south of the international boundary, and 60 miles west of the river, and some 700 feet above it, the railroad cuts all go down into shale.

These facts seem to point to the inference that the gathering ground of this water is on this sandy ridge. The fact that the pressure on east and west lines does not grow greater as the river is approached, although the country is lower, would indicate that the water came from the west. The fact that the pressure grows less as one comes south, until at Fargo the water will not come to the surface, would indicate that the ridge is the gathering ground, as its elevation above the river grows less to the southward.

ANALYSES OF ARTESIAN WELL WATERS OF NORTH DAKOTA—THE DEVILS LAKE WELL.

AGRICULTURAL COLLEGE, CHEMICAL DEPARTMENT.
FARGO, North Dakota, July 16, 1891.

W. W. Barrett, Lakota, N. D.

DEAR SIR:—The sample of the Devils Lake artesian well water sent for analyses by you contained:

	Parts.
Solids, per million	3,476 00
Chlorine, per million	810 00

The solids contained:

	Per Cent.
Sulphuric anhydride SO_3	23.96
Phosphoric anhydride P_2O_5	trace
Iron Fe_2O_3	trace
Potassium oxide K_2O	7.68
Sodium oxide Na_2O	42.18
Calcium oxide C_4O	0.80
Magnesium oxide MyO	trace

It will be seen from the above analyses the two principal ingredients are sodium chloride (common salt) and sodium sulphate (glanbers salts.) The undetermined matter is mostly sand, solids, etc., that were present in small quantities.

Respectfully yours,
E. F. LADD,
Chemist.

FROM THE JAMESTOWN WELL—(IN THE CITY.)

Organic matter: Free ammonia, 2.4 parts per million; albuminoid ammonia, .046 per million; nitrites, traces; nitrates, none.

INORGANIC MATTER.

Silica	35.70	2.0823
Alumini	3.50	.2041
Carbonate of iron	2.20	.1233
Carbonate of lime	188.00	10.7643
Sulphate of lime	249.00	14.5243
Sulphate of magnesia	154.20	8.9044
Sulphate of soda	1,139.40	66.3602
Chloride of sodium	369.10	21.5296
Sulphate of potash	31.05	4.7526
Phosphate	....	a trace
Hardness	....	21°

Grafton.—Three per cent. of salt in water, and slight trace of sulphate of magnesia.

Ellendale.—Water not pleasant to the taste; very soft.

Tower City—

	Grains in One United States Gallon.
Solid matter, upon evaporation to dryness	180.000
Sediment	none
Scale (deposited on evaporation to one-tenth bulk)	4.894
Silica	0.194
Alumina and oxide of iron	0.374
Lime	3.604
Magnesia	0.114
Carbonic acid	not det.
Sulphuric acid, free	none
Sulphuric acid in combination	31.990
Chlorine, free	none
Chlorine in combination	6.880
Potash and soda	residuum

Oakes.—Analysis made by James H. Shepard, of South Dakota Agricultural and Experiment station, June 19, 1890.

Bases: Iron and potassium, small quantities; calcium and sodium, much; magnesia, a little.

Acids: Silica, considerable; carbonic and sulphuric, moderate quantities; hydrochloric, much; total residue per liter, 2.810 grains.

COMPARISON OF ANALYSES.

In order to enable a comparison to be instituted between our artesian waters and waters from other places, I subjoin a statement of analyses of waters

From a Huron, S. D., well.—By a chemist in Chicago.

Silica	0.90
Sulphate of sodium	53.13
Sulphate of potassium	0.75
Sulphate of calcium	34.70
Sulphate of magensia, p	5.15
Carbonate of magnesium	7.60
Carbonate of iron	0.11
Alumnia, trace.	
Organic matter, trace.	
Total	102.34

An analysis of the river well—By Dr. Netherley.

	During Flood.	During low water.
Organic matter	15.02	10.37
Phosphoric acid	1.78	0.57
Lime	2.06	3.18
Magnesia	1.12	0.98
Potash	1.82	1.06
Soda	0.91	0.62
Aluminum and iron oxide	20.92	23.55
Silica	55.09	58.22
Carbonic acid and loss	1.28	1.44
Total	100.00	100.00

SPRINGS OF NORTH DAKOTA.

In our State many springs abound, consisting of what is termed "common water springs," soft or hard, mineral, medicinal and thermal; and also artesian springs. Often the flowage is large with pure sweet water, and all constitute an important part of the water supply of the State. All these springs, except those of an artesian nature, have their source from the phreatic or underflow waters.

A LIST OF SOME OF THE SPRINGS.

Name of Spring or Owner, When Known.	County.	Location.			Flow per Day, Gallons.	Remarks.
		Sec.	T.	R.		
	LaMoure					200 flowing springs on James river.
	Traill					Have not suffered from drought.
	McHenry					
	Kidder	31	139	73		Several large ponds.
	Kidder	32	139	73		
	Kidder	12	140	73		
	Kidder	12	140	73		
	Kidder	14	140	73		
	Kidder	35	137	74		
	Pierce	13	153	73		Irrigated by springs, 160 acres.
	Pierce	18	154	73		
	Pierce	6	156	72		
	Pierce	3	157	73		
	Pierce	35	158	73		
	Sargent	2	130	58		
	Sargent	27	132	56		
	Mercer	18	146	86		
	Mercer	16	144	86		
	Mercer	30	145	86		
	Mercer	20	144	85		
	Mercer	30	144	84		
	Mercer	30	145	84		
	Stark					Large number of small springs.
	Burleigh					
	Ransom	11	135	58		Three large lakes.
	Ransom	29	136	57		
	Dickey					No. of springs in west of county.
	Logan	8	133	71		
	Logan	10	133	71		

A LIST OF SOME OF THE SPRINGS.—*Continued.*

Name of Spring or Owner, When Known.	County.	Location.			Flow per Day, Gallons.	Remarks.
		Sec.	T.	R.		
	Logan	8	133	71		Of ponds, etc., 100.
	Rolette					Several springs on Maple river.
	Cass					At Fort Ransom Springs, 200 feet above river.
	Ransom	26	136	58		
	Ransom	19	135	58		A large number of ponds, etc.
	Pembina	16	159	56		
	Pembina	16	150	56		
	Eddy		149	64		
John Hennessy	Nelson				5,348	Near Stump lake.
Mrs. E. J. Phillips	Nelson				22,320	Near Stump lake.
Minnanappo (the Mission spring)	Rolette					Near the Mission house in the Indian reservation, Turtle mountains.
Minnehaba (the Steele spring)	Rolette				411,840	An artesian spring location, near 6 miles east of Dunseith; waters a herd of 1,000 sheep and cattle and forms a lake of unfailing supply on the plains; can be made to irrigate a large area of land.
Brewery spring	Rolette				18,000 estimated.	Near Dunseith.
Spalako Spring	Rolette				60,480	A noted and most remarkable artesian mineral spring in the Turtle mountains near Dunseith.
McBravan Spring	Bottineau				23,040	One mile from Bottineau.
The Koranee Spring	Bottineau				30,000 estimated.	A most attractive mineral spring on the mountain side, on the John Hawfacker place, near Bottineau; water sufficient to irrigate large areas on prairie below.
	Dickey					Two springs near three miles from State line; can be made to irrigate probably 200 to 300 acres.
			131	65		Three springs; location good for irrigation purposes; will irrigate probably 300 to 400 acres.
	LaMoure		133	65		A number of springs; enough to irrigate 500 acres.
	Stutsman	16	144	67		Large marsh. The water can be made to irrigate probably 300 to 400 acres.
	Wells	25	145			On each side of the Hawk's Nest is a running spring which will irrigate 300 to 400 acres.

USEFUL MEMORANDA RELATING TO WATER.

In order to assist those who desire authentic information in regard to rainfall, service of water, and such matters as are necessary to know in conducting irrigation enterprises, I subjoin the following valuable tables. They are reliable, having been prepared with great care by Mr. Frank Blaisdell, the engineer expert of the artesian and underflow irrigation investigation of 1891.

The chemical composition of pure water is:

By volume—		By weight—	
Hydrogen	2	Hydrogen	1
Oxygen	1	Oxygen	8

One cubic foot of water at 62 degrees Fahenheit=62.321 pounds; cubic feet in one ton, 2,000 pounds = 32.09.

One cubic foot at 62 is 427 grains lighter than water at maximum density 39.38 degrees, or .976 ounces, or nearly an ounce.

Gallons in a cubic foot = 7.4805; gallons in a cubic yard = 201.9735.

Weight of one gallon at 39.38 degrees = 8.3393 pounds; weight of one gallon 62 degrees = 8.3311 pounds.

At 39.38 degrees a column of water of one square inch base and 12 inches high gives .433 pounds pressure. At 62 degrees the same volume gives .4328 pounds pressure.

At 39.38 degrees a column of water of one square inch base and 2.3084 feet (27.711 inches) high gives one pound pressure.

At 62 degrees 2.3105 feet (27.726 inches) height is required to give one pound pressure.

One cubic inch of water at 39.38 degrees = .0361 pounds; one cubic inch of water at 62 degrees = .03606 pounds.

One inch of rainfall on one acre = 3,630 cubic feet, or 27,154.4 gallons, or 113.12 tons.

One foot, 12 inches of rainfall on an acre = 43,560 cubic feet, or 325,852.8 gallons, or 1,354.74 tons.

One inch of rainfall on one square mile, 640 acres = 2,323,200 cubic feet, or 17,378,816 gallons.

One foot of rainfall on one square mile = 27,878,400 cubic feet = 208,545,792 gallons.

A MINER'S INCH OF WATER.

This is usually estimated in the amount that will flow through an opening one inch square, under a head of six inches above the upper side of opening, this giving a discharge of about 12 United States gallons per minute. In some parts of California the head is taken at four inches above upper side of opening, which gives a discharge of about nine gallons per minute.

Fifty miner's inches equal one cubic foot per second.

To ascertain gross power for raising water, multiply the number of gallons per minute by the height in feet and divide by 2,000.

One ton of good coal, or its equivalent in other fuel, will raise 5,000,000 gallons of water 20 feet high.

Five million gallons will cover 100 acres 2¼ inches deep, or is equal to one inch of water on 250 acres.

The speed of a centrifugal pump is found by multiplying the square root of the head in feet by 500 and adding 550. This gives the speed of the runner in feet per minute at the periphery.

One arc-foot of water is 43,560 cubic feet, or one foot of water 12 inches deep over one square acre.

SNOW AND ICE.

Water expands in freezing about one-twelfth of its bulk, or from 1,000 to 1,083.

Specific gravity of ice.................. 0.916 Ure.
Specific gravity of ice.................. 0.918 Miller.
Specific gravity of ice.................. 0.9184 Abel & Bloxam.

One thousand five hundred ninety five cubic inches of water will expand in freezing to one cubic foot of ice.

One cubic foot of ice weighs............ 57.135 Ure.
One cubic foot of ice weighs............ 57.260 Miller.
One cubic foot of ice weighs............ 58.632 Abel & Bloxam.

Sound ice two inches thick will bear the weight of the average man; four inches a man on horseback; six inches cattle and teams with light loads; eight inches, teams with heavy loads; 10 inches will sustain a pressure of 1,000 pounds per square foot. The ice must be sound, free from shakes, cracks and frozen snow.

Snow is 10 or 12 times lighter than an equal volume of water; that is, one inch of rainfall will make from 10 to 12 inches of good, crystalline snow.

Molesworth gives the following relating to snow:

Specific gravity is 0.0833; one cubic inch of snow = 0.003 pound; one cubic foot of snow = 5.2 pounds; one pound of snow = 332.6 cubic inches; one pound of snow = 0.1923 cubic foot; one inch snow fall = 0.433 pounds per square foot.

The pressure of the atmosphere is 14.73 pounds per square inch at the mean level of the sea, the mercurial column standing at 30 inches.

The atmosphere will balance a column of water 34 feet high.

Common pumps will lift water by suction about 25 feet. Steam pumps will not work well with over 18 feet suction.

Each nominal horse power of boilers requires one cubic foot of water per hour. In calculating horse power of steam boilers, consider, for tubular boilers, 15 square feet of heating surface equivalent to one horse power; flue boilers, 12 square feet of heating surface equivalent to one horse power; cylinder boilers, 10 square feet of heating surface equal to one horse power.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434.

FORMULÆ FOR ESTIMATING THE QUANTITY OF WATER RAISED BY PUMPING ENGINES AND THE AMOUNT OF POWER REQUIRED.

=Quantity of water raised per minute in cubic feet.

H=Height or lift of pump in feet.

G=Gallons raised per minute.

P=Pressure in pounds per square inch due to the head or lift H, as indicated by the water-pressure guage.

HP=Nominal horse-power or the power required to lift 33,000 pounds 1 foot high in 1 minute.

D=Diameter of pumping cylinder in inches.

S=Length of stroke of the piston in inches.

Formulæ for finding the quantity of water thrown at each stroke of the piston of a pump:

$0.7854 \times D^2S$ = Total cubic inches displaced.
$0.0034 \times D^2S$ = United States gallons.
$0.0004545 \times D^2S$ = Cubic feet.
$0.02832 \times D^2S$ = Pounds of water 62° Fahrenheit.

To find the nominal horse power required to raise certain quantities of water:

$$HP=\frac{QH}{529}$$

$$HP=0.00189\ QH$$

$$HP=0.00436\ QP$$

The actual horse power required to raise water is placed by some authors from 60 to 80 per cent. over the nominal.

If the dimensions are taken in *feet* and the coefficients modified accordingly, these formulæ are applicable to the estimation of the capacity of standpipes, cisterns, boilers and all straight cylinders with circular sections.

In these formulæ let H=the height of the standpipe, depth of the cistern, length of the boiler or water pipe in feet. All other dimensions to be in feet.

$0.7854 \times D^2H$ = Cubic feet.
$5.8748 \times D^2H$ = Gallons.
$48.947 \times D^2H$ = Pounds of water.
$0.02447 \times D^2H$ = Tons of 2,000 pounds each.

That is, square the diameter of the given cylinder, multiply it by the length, and this product by the given coefficient, and the result in each case will be in terms as stated in the formula.

TABLE GIVING THE UNITED STATES GALLONS IN THE NUMBER OF CUBIC FEET SHOWN IN THE LEFT-HAND COLUMNS.

Cubic Feet.	Gallons.	Cubic Feet.	Gallons.	Cubic Feet.	Gallons.
0.1	0.75	50	374.0	8,000	59,844.1
0.2	1.50	60	448.8	9,000	67,324.6
0.3	2.24	70	523.6	10,000	74,805.2
0.4	2.99	80	598.4	20,000	149,610.4
0.5	3.74	90	673.2	30,000	224,415.6
0.6	4.49	100	748.0	40,000	299,220.7
0.7	5.24	200	1,496.1	50,000	374,025.9
0.8	5.98	300	2,244.1	60,000	448,831.1
0 9	6.73	400	2,992.2	70,000	523,636.3
1	7.48	500	3,740.2	80,000	598,441.5
2	14.9	600	4,488.3	90,000	673,246.7
3	22.4	700	5,236.3	100,000	748,051.9
4	29.9	800	5,984.4	200,000	1,496,103.8
5	37.4	900	6,732.4	300,000	2,224,155.7
6	44.9	1,000	7,480.0	400,000	2,992,207.6
7	52.4	2,000	14,961.0	500,000	3,470,259.5
8	59.8	3,000	22,441.5	600,000	4,488,311.4
9	67.3	4,000	29,992.0	700,000	5,236,363.3
10	74.8	5,000	37,402.6	800,000	5,984,415.2
20	149.6	6,000	44,883.1	900,000	6,732,467.1
30	224.4	7,000	52,363.6	1,000,000	7,480,519.0
40	299.5				

From the foregoing table the number of gallons in a given number of cubic feet may be computed by simple addition.

EXAMPLE.

How many gallons in 37,629 cubic feet?

30,000	224,415.6
7,000	52,363.6
600	4,488.3
20	149.6
9	67.8
Gallons	281,484.4

CUBIC MEASURES.

Inches.	Feet.	Yard.	Cubic Metres.
1 equals	.00005788	.000002144	.000016386
1728 "	1.	.03704	.028315
46656 "	27.	1.	.764513

One cubic foot equals 7.48 United States liquid gallons of 231 cubic inches.

One cubic foot equals .23748 United States liquid barrel of 31½ gallons.

One cubic foot equals .803561 United States bushels of 2150.42 cubic feet.

CAPACITY OF CISTERNS IN BARRELS OF UNITED STATES STANDARD, 31½ GALLONS.

Depth in Feet.	Diameter in Feet.										
	5	6	7	8	9	10	11	12	13	14	15
5	23.3	33.6	45.7	59.7	75.5	93.2	112.8	134.3	157.6	182.8	209.8
6	28.0	40.3	54.8	71.7	90.6	111.9	135.4	161.1	189.1	219.3	251.8
7	32.7	47.0	64.0	83.6	105.7	130.6	158.0	188.0	220.6	255.9	293.7
8	37.3	53.7	73.1	95.5	120.9	149.2	180.5	214.8	252.1	292.4	335.7
9	42.0	60.4	82.2	107.4	136.0	167.9	203.1	241.7	283.7	329.0	377.7
10	46.7	67.1	91.4	119.4	151.1	186.5	225.7	268.6	315.2	365.5	419.6
11	51.3	73.9	100.5	131.3	166.2	205.1	248.2	295.4	346.7	402.1	461.6
12	56.0	80.6	109.7	143.2	181.3	223.8	270.8	322.3	378.2	438.6	503.5
13	60.7	87.3	118.8	155.2	196.4	242.4	293.4	349.1	409.7	475.2	545.5
14	65.3	94.0	127.9	167.1	211.5	261.1	315.9	376.0	441.3	511.8	587.5
15	70.0	100.7	137.1	179.0	226.6	279.8	338.5	402.8	472.8	548.3	629.4
16	74.7	107.4	146.2	191.0	241.7	298.4	361.1	429.7	504.3	584.9	671.4
17	79.3	114.1	155.4	202.9	256.8	317.0	383.6	456.6	535.8	621.4	713.4
18	84.0	120.9	164.5	214.8	272.0	335.7	406.2	483.4	567.3	658.0	755.3
19	88.7	127.6	173.6	226 8	287.0	354.3	428.8	510.3	598.9	694.5	797.3
20	93.3	134.3	182.8	238.7	302.1	373.0	451.3	537.1	630.4	731.1	839.3

Diameter of a circle multiplied by 3.1416 equals circumference.
Circumference multiplied by .31831 equals diameter.
Square of diameter multiplied by .7854 equals area.
Cube of diameter of sphere multiplied by .5236 equals solidity.
Doubling the diameter of a pipe increases its capacity four times.
Friction of liquids in pipes increases as the square of the velocity.

RAINFALL MEASURES.

The following table shows the quantity in cubic feet and gallons per acre from one-tenth to one inch rainfall:

Depth of Rain.	Per Acre.	Per Acre.
Inch.	Cubic feet.	Gallons.
0.1	363	2,262
.2	726	4,524
.3	1,088	6,787
.4	1,452	9,046
.5	1,815	11,211
0.6	2,178	13,573
.7	2,541	15,830
.8	2,904	18,098
.9	3,267	20,360
1	3,630	22,622

LONG MEASURE.

Inches.		Feet.	Yards.	Fathoms.	Rods.	Furlongs.	Mile.	French Meter.
1	equals	0.083	0.02778	0.0139	0.005	0.000126	0.0000158	0.0254
12		1	.333	.1667	.0606	.00151	.0001984	.3048
36		3	1	.5	.182	.00454	.000568	.9144
72		6	2	1	.364	.0091	.001136	1.8287
198		16½	5½	2¾	1	.025	.003125	5.0291
7920		660	220	110	40	1	.125	201.16
63360		5280	1760	880	320	8	1	1609.315

A palm equals three inches.
A span equals nine inches.
A hand equals four inches.
A cable's length equals 120 fathoms.

SURVEYING MEASURE (LINEAL).

Inches.	Links.	Feet.	Yards.	Chain.	Mile.	French Meter.
1 equals	0.126	0.0833	0.0378	0.00126	0.0000158	0.0254
7.92 "	1.	.66	.22	.01	.000125	.2012
12 "	1.515	1	.333	.01515	.000189	.3048
36 "	4.545	3	1	.04545	.000568	.9144
792 "	100	66	22	1	.0125	20.116
63,360 "	8,000	5,280	1,760	80	1	1,609.315

One knot or geographical mile equals 6,086.07 feet or 1,855.11 meters or 1,1526 statute miles.

AVOIRDUPOIS WEIGHT.

The standard avoirdupois pound is the weight of 27,5015 cubic inches of distilled water, weighed in the air, at 30.84 degrees Fahrenheit, barometer at 30 inches; 27.343 grains equals one drachm.

Drachms.		Ounces.	Pounds.	Quarters.	Cwts.	Tons.	French Grams.
1	equals	0.0625	0.0039	0.000139	0.000035	0.00000174	1.771846
16		1	.0625	.00223	.000558	.000028	28.34954
156		16	1	.0357	.00893	.000447	454.59
7,168		448	28	1	.25	.0125	12,700
28,672		1,792	112	4	1	.05	50,806
573,440		35,840	2,240	80	20	1	1,016,048

A stone equals 14 pounds.
A quintal equals 100 pounds.
7,000 grains equals one avoirdupois pound, or 1.21528 troy pounds.
5,760 grains equals one troy pound, or 0.82285 avoirdupois pound.

SQUARE MEASURE.

Inches.		Feet.	Yards.	Perches.	Rods.	Acres.
1	equals	0.00694	0.000772	0.0000255	0.00000064	0.000000159
144	"	1	.111	.00367	.0000918	.000023
1,296	"	9	1	.0331	.000826	.0002066
39,204	"	272¼	30¼	1	.025	.00625
1,568,160	"	10,890	1,210	40	1	.25
6,172,640	"	43,560	4,840	160	4	1

100 square feet equals one square.

One square mile equals 27,878,400 square feet or 3,097,600 square yards, or 640 acres.

A section of land is one mile square, and contains 640 acres.

A square acre is 208.71 feet at each side, or 220x198. A circular acre is 235,504 feet in diameter.

WEIR TABLE.

Below is furnished a Weir table from one-eighth inch to twenty inches in depth by one inch in width.

Inches.	Parts of an Inch.	⅛	¼	⅜	½	⅝	¾	⅞	Parts of an Inch.	Inches.
		.01	.05	.09	.14	.20	.26	.33		
1	.40	.47	.55	.65	.74	.83	.93	1.03	.40	 1
2	1.14	1.24	1.36	1.47	1.59	1.71	1.83	1.96	1.14	 2
3	2.06	2.23	2.36	2.50	2.63	2.78	2.92	3.07	2.06	 3
4	3.22	3.37	3.52	3.68	3.83	3.99	4.16	4.32	3.22	 4
5	4.50	4.67	4.84	5.01	5.18	5.36	5.54	5.72	4.50	 5
6	5.90	6.09	6.28	6.47	6.65	6.84	7.05	7.27	5.90	 6
7	7.40	7.64	7.84	8.05	8.25	8.45	8.56	8.86	7.44	 7
8	9.10	9.31	9.52	9.74	9.96	10.18	10.40	10.62	9.10	 8
9	10.86	11.08	11.31	11.54	11.77	12.00	12.23	12.47	10.86	 9
10	12.71	13.95	13.19	13.43	13.67	13.93	14.16	14.42	12.71	 10
11	14.67	14.92	15.18	15.43	15.67	15.96	16.20	16.46	14.67	 11
12	16.73	16.99	17.26	17.52	17.78	18.05	18.32	18.59	16.73	 12
13	18.87	19.14	19.42	16.69	18.97	20.24	20.52	20.80	18.87	 13
14	21.09	21.37	21.65	21.94	22.22	22.51	22.79	23.08	21.09	 14
15	23.38	23.67	23.97	24.26	24.56	24.86	25.16	25.46	23.38	 15
16	25.76	26.06	26.36	26.66	26.97	27.27	27.58	27.89	25.76	 16
17	28.20	28.51	28.92	29.14	29.45	29.76	30.08	30.39	28.20	 17
18	30.70	31.02	31.34	31.65	31.99	32.31	32.63	32.96	30.70	 18
19	33.29	33.61	33.94	34.27	34.60	34.94	35.27	35.60	33.29	 19
20	35.94	36.27	36.60	36.94	37.28	37.92	37.96	38.31	35.94	 20

EQUIVALENTS OF UNITS USED IN MEASURING WATER FOR IRRIGATION PURPOSES.

Prepared by Col. Edwin S. Nettleton, chief engineer of Irrigation and Underflow Investigation.

UNITED STATES GALLONS.

100 gallons per minute equals—
.44 acre foot in 24 hours.
13.25 acre feet in 30 days.
40.00 acre feet in 3 months.
160.00 acre feet in 1 year.
1.00 acre foot in 55 hours.
.223 acre foot in 1 second.
11 1-6 California (miners') inches.
8½ Colorado (miners') inches.
1 United States gallon equals 231 cubic inches or 1.748 cubic feet.

CALIFORNIA INCHES.

100 California inches equals—
4 acre feet in 24 hours.
1 acre foot in 6 hours.
120 acre feet in 30 days.
360 acre feet in 3 months.
1,440 acre feet in 1 year.
15 gallons per second.
900 gallons per minute.
77 Colorado inches.
2 cubic feet per second.

COLORADO INCHES.

100 Colorado inches equals—
5 1-16 acre feet in 24 hours.
1 acre foot in 4.2 hours.
155 acre feet in 1 month.
465 acre feet in 3 months.
1,860 acre feet in 1 year.
19.50 gallons per second.
1,770 gallons per minute.
2.6 cubic feet per second.
130 California inches.

CUBIC FEET.

1 cubic foot per second equals—
2 acre feet in 24 hours.
60 acre feet in 30 hours.
180 acre feet in 3 months.
720 acre feet in 1 year.
7.48 gallons per second.
449 gallons per minute.
50 California inches.
38.4 Colorado inches.
1 acre foot equals 42,560 cubic feet, or 1 acre 1 foot deep.
1 cubic foot equals 7.48 gallons (usually called 7½.)

An acre foot is one foot solid, or 12 inches square, over an acre of land.

EXPLANATION OF THE WEIR TABLE.

How many cubic feet will pass over a weir five feet wide and six and one-half inches in depth? We find six in the left hand column, and trace to the right until we come to ½ in the heading, and there discover the number to be 6.65, which indicates that six and sixty-five hundredths cubic feet of water will flow over an aperature in the weir six and one-half inches deep and one-inch in width. We multiply this (6.65) by 60, the number of inches in five feet, and find 6.65x60=399.00 cubic feet, the amount of water that will discharge over a weir six and one-half inches deep and 60 inches wide.

HOW TO MEASURE THE WATER.

Take a plank or board, cut a notch in it six and a half inches deep and five feet wide. Secure it in place by means of stakes driven into the ground. Stop the escape of water by the use of sods. This done, cut a notch in a stake and drive the stake into the soil a short distance from the upper side of the plank, and near the edge of the pond. Drive the stake down until the notch shall index, or be even, with the notch as it first commences to flow over the bottom of the notch.

When the water has reached its full height, the cubic feet of discharge can be determined by measuring the depth of the water above the notch on the stick and then finding the flow for that depth in the table, and multiplying it by the width of the notch in the plank, the width being reduced to inches, as explained above.

The bottom and the sides of the notch on the down stream side should be leveled so as to prevent too much friction of the water during the discharge.

Width of notch not to exceed two-thirds of the width of the stream between enclosed banks. The notch should be set level and four or five or more inches above the level of the water below the weir.

The Forestation of North Dakota

AND OTHER WESTERN STATES

Is of Paramount Importance,

AND THEY WHO AID IN THE ECONOMIC REFORM WILL BENEFIT
THE STATE AND BLESS THE PEOPLE.

CAPULIFERÆ.—OAK FAMILY.

By all authors the oak is classed as one of the most useful trees of the globe. Because of its good qualities it is often called the "monarch of the forests." Having great durability, solidity, tenacity and strength of fiber, it is eagerly sought for the construction of cars, ships, bridges, and where great resistance is required. It likewise enters largely into the various parts of agricultural machinery and husbandry of various descriptions. It fails to produce good seed until about the sixth year from its planting and generally fails to give heavy crops of seed two successive years. Its productiveness seems to increase with age. It takes nearly a half dozen years for this "monarch" to get a good foothold in the soil, but from then on, if favored with right conditions, it grows rapidly for 40 or 50 years. Some kinds have great longevity, living, according to good authority, upwards of 1,000 years.

Prof. Asa Gray names 32 species of the oak family found in the United States. Across the line in Minnesota, Prof. Warren Upham mentions fourteen kinds, and here in North Dakota we find numerous varieties.

THE WHITE OAK.—*Quercus Alba.*

The White or American Oak is found in a large proportion of the area of North America. It is common in the Eastern and Middle states, the Canadas and as far North as Lake Winnipeg, where it is claimed its height is restricted to 15 and 20 feet. It abounds in Minnesota and in North Dakota. In our state it reaches a large size. I have found many trees of this kind with a diameter of from three to four feet. Oaks of these dimensions, tall and stately, reaching a height of 75 to 85 feet, adorn "The Sylvatan Park", which renowned and beautiful spot is found on the North Dakota side of the Red river, nearly four miles south of Grand Forks. Here these hardy and healthy trees attract the thoughtful attention and awaken the delight of the many visitors who seek this favored retreat for study and recreation. Fine specimens of this tree were secured from this park for the great World's Columbian Fair.

This tree also grows in large quantities and of fair size and good height in "The Picture Park," or timber reserve in the Turtle mountains, in the Devils lake woods, "The State Militia Park," the Chautauqua grounds and along the various rivers and streams of the State.

The soil and climate have much to do with the quality and size of the white oak. It has better fiber and attains a larger size in deep rich soils, though it will grow and flourish in gravelly and steril lands.

It is easily distinguished from other oak by its leaves, which are regular and oblique, divided into oblong rounded lobes, which are destitute of points. The observant also readily distinguish this tree from others by the whiteness of its bark, which is often varigated with large black spots. The bark is often employed for tanning purposes. It is most interesting and instructive to inspect and study the acorns of this tree. Their color is light brown, are of large size and sweet, and the meat is stored away in rough grayish cups, single or in pairs. A reddish tint constitutes the color of the wood. It enters into the manufactory of furniture, carriage and wagon wheels, car frames, the wood work of all kinds of plows, water crafts, and many of the things that demand durability, solidity and strength.

The demand for the wood of this tree is great and constantly increasing, and it cannot be many years before, for commercial purposes, it will become practically extinct. Should not this fact incite the public to take proper steps for its better protection and growth?

SCARLET OAK.—*Quercus Coccinia.*

This oak is not infrequently found on the Upper Mississippi scattered through other oaks. It is claimed to be a native of North Dakota. In localities of favorable conditions it reaches eighty or more feet, having a diameter of three or four feet. The bark is gray and its interior reddish. Its wood is also reddish, grain coarse, open pores, and makes good staves, but its timber is poor compared with white or red oaks. Its leaves have an attractive green, smooth and shiny on upper and lower surface, deep, narrow lobes resembling in perspective, green-bordered bays. They attain a bright red after successive frosts. The acorns are large and considerably elongated; cups coarse and scaly, and enwrap the round acorns more than half their length. This tree would probably flourish well on our prairies, as it does well on dry soils.

THE POST OAK.—*Quercus Obtusiboba.*

The Post oak is sometimes known as the Box-white oak and also the iron oak. It is infrequent in the soil region of the upper Mississippi. The acorns are small and covered for about one-third of their length in a grayish rugged cup. The limit of its growth is about fifteen inches in diameter and height 40 to 50 feet; grayish white bark; leaves thick and color grayish, pale and rough above and downy beneath. Its timber resembles the white oak, and being tough and hardy, under judicious management it would doubtless prove a valuable tree for cultivation in our State.

THE BUR OAK.—*Quercus Macrocapa.*

The Bur oak, also called the Quer-cup or Mossy-cup White oak, is common in our State and throughout the west. It grows in all kinds of soil and is a tenacious, vigorous tree. Its northern limit, according to Bell, is the region of country north of Lake Superior, not far from the international line.

It has larger leaves than any other oak in the union. They sometimes are found fifteen inches long and eight inches broad, which are lace shape and notched near the summit; "Obovate" (broad and upward), or oblong lyrately pinnatified (lobed like a lyre). It has various shapes, downy and pale beneath and smooth above. The cup has a thick shell and rugged and found to cover near two-thirds of the acorn; pointed hard scales, that is the upper ones, diminishing down to bristly points, constituting a fringed border of a mossy like nature. However, in compact bodies these flexible filaments are absent, the edge being smooth and bent inward.

The Bur oak is not abundant in its fructification. On the deep alluvial bottoms it grows rank and tall, sound and full meted, while on steril soil it is small. At home in its best estate, it reaches 60 to 70 feet in height. Its bark resembles in many respects those of the cork elm. This tree is found in nearly all the woods of our commmonwealth. Its many sensible qualities are deserving of more attention than is generally accorded to this tree, and it would probably pay to plant and cultivate it with care on our extended plains.

JACK OR BEAR OAK.—*Quercus Banisteri Nuttall.*

The Jack or Bear oak, and often called the Black Jack, is indigenous to North Dakota, being found in most all the woods therein. This is a prolific tree when once rooted, especially in barren and sandy regions. It is small and bushy, growing to small height, but finds an extension, in favorable localities, of 15 to 25 feet, with but a few inches in diameter. It grows in clusters, often forming dense thickets so close as to prevent the passage of cattle and large wild animals. These characteristics point to the fact that it would make good wind breaks, and in winter would be equal, seemingly, to evergreen hedges for the reason, amongst other things, that its leaves hang on through all the blasts and colds until forced off by the buds of spring. Mr. Hodges says: "It is an excellent tree to plant for shelter belts, serving the same purpose in this regard as the evergreens to screen the farms from the cold blasts of winter." Like all other varieties of oak it makes excellent fuel.

SWAMP SPANISH OR PIN OAK.—*Quercus Palustris.*

Found in moist places, and grows tall. On the Upper Mississippi it keeps to the swamps and low lands, finding good protection from other trees. Often in good soil it has a base of three or four feet in diameter and towers eighty feet or more. Its secondary branches are quite numerous, of slender form and intermingled in a high degree.

The leaves resemble those of the Scarlet oak, the difference being mainly in the proportions. The acorns are held in saucer-like cups, having short scales. The acorns are round and small.

The bark has cellular tissues very thick; it is adhesive and rarely cracks. The wood is coarse, porous and open. Its pyramidal shape and attractive foliage makes it a favorite for parks and lawns. It is a native of our State and should be cultivated in the low, marshy grounds bordering our streams and lakes.

RED OAK.—*Quercus Rubra.*

The cool north land is the habitat of the Red Oak, one of the most deservable of the whole family of trees. It ranks well even in poor soil with its congeners like situated. Prof. Gray claims it is deserving of praise, and every other botanist has a good word for it, and it is popular with the masses, who know its worth. A large tree, color dary gray, with smooth bark; wood is coarse and reddish. The pores are large and open, admitting a needle; fibre strong and the wood is used for furniture, staves and dry wares of various kinds.

The leaves are smooth, bright and shiny on upper and lower side, large, deeply laciniated (slashed), with a rounded form at the base. In autumn the leaves assume dull or dingy red, turning to a yellow tinge before falling. The acorns are large and generally abundant and furnish good food for sheep, cattle, bears and other wild animals, and hogs fatten on their nutritious elements. The cups are most attractive, short and saucer-shape, held in a narrow neck. It is found to be the first American oak introduced into Europe. It abounds in many divisions of North America; it flourishes in the various woods of our State, and extends as far north, at least, as the Saskatchewan and the rock land of Lake Namakeen. All its friends, and they are many, admire its excellent qualities, clean and good habits, and love its enchanting beauty. The White and Red oak are twin brothers, valued and cherished in every land and clime.

This tree is acclimated and indigenous to our soil and climate, and our people will be wise to encourage its growth by careful planting and intelligent culture.

HOP-HORNBEAM.—ASTRAYA VIRGINICA.

The American, or Hop-Hornbeam, has numerous other names, such as Ironwood, Leverwood, and other distinctions. It has been found in abundance by the writer in Minnesota, and I have also found it in all woods where I have explored in North Dakota. The diameter of those growing in our State is from two to five inches, and height from 15 to 25 feet.

Its leaves are alternate, oval-shaped, pointed taper-like and fine-toothed. They resemble the leaves of the birch to a high degree. The flowers appear in the spring at the extremities of the branches, and the fruit appears in clusters like hops. In oval, reddish, protruding bladders, the seeds, small, hard and triangular make their appearance. In winter the bark is smooth and grayish, and finely divided into detached strips. The wood is compact, heavy, fine-grained and of a white color. The woodmen use it for levers and the mechanics for mill clogs, mallets, blocks, tool handles, etc. It grows slowly and is very hardy.

Carpinus Americàna is the true American hornbeam, which is also known as the blue or water beech. This is a short tree, furrowed trunk, bark gray and close over very hard wood. The leaves are small, something like the beech. The flowers appear in the spring with the leaves. It is quite indifferent as to the nature of the soil in which it grows. It has many admirers for its unique beauty. Its hardy nature, toughness and attractions recommend it as a good tree for places in connection with other trees on our plains.

THE BEECH.—*Fogus ferruginea.*

This tree abounds throughout the Eastern and Middle states and is found native in Eastern Wisconsin. It thrives in moist soil and a cool atmosphere. It is not suited to our dry prairies, but might be cultivated, under proper conditions, in the moist alluvial soils along our rivers and the marshes or wet lands of the mountain forests where it would find shelter from other trees.

Near my father's homestead in the state of Maine large groups or groves of the beech occupied the forests on the hill tops, acclivities and in the valleys near the water brooks and cascades. These trees, smooth bark of a slate color, adorned with mosses, arose from 80 to 90 or more feet, up and above many other species. They grew straight and slender, having a diameter of one and a half to two feet. The first branches were often 50 to 60 feet from the ground, extending with the others far out and up 15 to 25 feet. The seeds, three-cornered, broad and smooth, contained a meat, juicy, wholesome and sweet, snow white with light shade of a creamy hue, the favorite nut of the boys, the squirrels and the bears. The odd-shaped nuts were sheltered in a shaggy cup, the filaments or pointed points having some resemblance to the chestnut burr. Generally but two seeds occupy one burr. These unique nuts ripen in October, when, with my brothers and schoolmates, I always sought the sacred groves to climb the tree and shake the limbs. The seeds, already loosened in the burrs, would descend in showers of shining brown drops upon the canvass or sheets spread upon the mantle of leaves over a foot deep upon the the forest floor. A number of bushels would thus be gathered from each tree.

The wood of this tree is employed in the manufacture of furniture of many kinds. It is easily split and is used extensively, where grown, for fuel.

Should any desire to propagate this valuable tree the seeds should be procured from the North, such as Eastern Wisconsin furnishes. Plant soon after ripening, if possible, under tree shade, forgetting not, however, it needs light for healthy sprouting and growth. As the young thing begins to grow, thin out the old shading trees, that it may become acclimated under favorable conditions. At the end of three or four years nearly all the supports may be safely removed, thus giving ample light and ventilation. Let all who love the nut trees give the beech a fair trial in our favored State.

URTICACEÆ.—ELM FAMILY.

The Elm belongs to the Nettle family, which, according to Gray, includes thirty-eight or more species and varieties in the United States. This is a hardy, thrifty, and long-lived tree. It has many commendable habits, and as an ornamental tree has but few equals. It seems partial to the light of the sun, filling every available space in the forest with its extended branches, that it may enjoy its influences. It grows to mammoth size in various parts of the state, especially on the Red and Missouri rivers and in the Devils lake woods.

This most deservable tree is cultivated in many parts of the State and should adorn the home yard and farm of every owner and tiller of the land in the State. Numerous varieties abound throughout the State.

WHITE ELM.—*Ulmus Americana.*

The White or American elm is magnificent. It ranges over a vast area from New Foundland to Florida, and as far west as the eastern foothills of the Rocky mountains. It adapts itself to different kinds of soil, thriving, with proper treatment, on the prairies central on the continent. It leads all the other elms in hardness, size, foliage and beauty. It is a fast grower; in deep, rich soil and favorable environment, known to attain from two to three feet or more diameter in half a century.

Evidently there are different types of this tree, two especially marked. In the alluvial soil of the Missouri, and other valleys of North Dakota, some of these species branch out from near the ground, towering up in grand balance, forming large, round heads, the tips of the branches drooping somewhat like the weeping willow. The shade of this species, when the tree is matured, covers a large area, the branches being so freely, yet connectedly, spread out umbrella shape.

Another conspicuous type is characterized by a single straight trunk, crowned with a smaller and flatter head, and with less shade. It branches higher up from the ground than the former, self-pruned, leaving a long, solid trunk, 30, 40 and even 50 feet, in some cases, free from limbs save now and then abortive branchlets, which in time scale off. As a rule this tree seldom needs any pruning.

Leaves, short stalked, oval, taper pointed. Flowers in April, purplish, clustered. Fruit flat, fringed with a dense down. Easily grown. Matures in June. Then plant it in thin light loam. No tree should be planted more extensively. It belongs to the centuries.

Generally, this elm is hard to split; hence its wood is very useful for wheels, saddle-trees, special kinds of coopering, for keels to small boats, and some other mechanical structures. Quite substantial rope can be made from its macerated bark. When sawed quartering, polished and varnished, it is, in most instances, as beautiful as the black walnut or bird's-eye maple. This tree attains a large size in the various woods of our State. Many of these magnificent elms are scattered through the woods of Sylvatan Park.

SLIPPERY ELM.—*Ulmus fulva.*

Also known as Red and Moose elm, and by the American-French as the *Arme gras*. This tree does not grow to the size of the White elm, nor is it as common. It thrives in a well drained soil, while that variety of the white called the water elm, prefers a low, alluvial soil. In favorable localities of our State it attains 15 to 20 inches in diameter and from 50 to 60 feet in height. It can be readily distinguished in winter from the white by the buds, which are rounder and larger, and in their early development by being covered by a russet down. Its leaves are also larger, thicker and rougher. "These and the flowers," says Gray, "are sweet scented in drying." The flowers are grouped at the extremity of young shoots. "Seed in the middle of the orbicular or round oval fruit, far away from the shallow notch." The trunk-bark is brown, heart of a dull red tinge. The wood appears a perfect make-up and very beautiful when well polished and varnished. When exposed to the weather it is of a better quality and more durable than the White elm. It is valuable for blocks, ox-yokes, etc. "Well known for its mucilaginous, medicinal inner bark." As an ornamental tree it is not as gracefully balanced as the White elm, but for utility it should be extensively planted and carefully preserved in our woodlands and cultivated groves.

CORK ELM.—*Ulmus racemosa.*

The other names for this tree are the White Corky and Rock elm. For wheelwright, furniture, and other purposes, it is the most valuable of all the elms; its wood is drier, whiter, cleaner rifted, and finer in constituency. It extends north on the higher shores of the upper Missouri and its tributaries. In some particulars it resembles the White elm, but is easily distinguished by its peculiar color and cleft of bark. The lower branches have corky excrescences; young branchlets downy-haired. The bud-scales are fringed with hairs. The leaves have straighter viens than those of the White. Flowers are clustered; two to four together, the stalk of each particular flower in the cluster being arranged along the sides of a general peduncle (flower-stalk). The winged fruit is elliptical and the margin deeply fringed. This elm is deserving of special attention. It abounds in the various woods of our State.

LINDEN FAMILY.—*Tiliaceæ.*

Tilia Americana is known as Basswood, Linden, Lime Tree, Whitewood. It is a tree of beauty, a rapid grower, clean in its habits, straight, regularly shaped, and, as it deserves, is much esteemed. Its wood is fine and enters largely into most kinds of wood work and cabinet work. It attains a large size and height. On the Red river, it has a height of 70 to 75 feet, with a diameter of 2 to 2½ feet. It constitutes one of the chief beauties of the Sylvatan Park.

When but a few years old the leaves are remarkably large, sometimes growing 14 to 15 inches long and a foot wide, suspended down a petiole (footstalk) about three inches long. On mature trees they are smaller. They are attached alternate, nearly round, heart-shaped at the base. Both sides are quite smooth. The flowers have numerous stamens or fertilizing organs. "Their filaments," says Gray, "cohering in five clusters, sometimes with a petal-like body in each cluster; others two-celled pistil with a five-celled ovary, having two ovals in each cell, in fruit becoming rather woody, globular, one-seeded little nut. * * * Dull, cream-colored, honey-bearing flowers formed in early summer on a nodding axillary peduncle (flower-stalk) which is united to a long and narrow leaf-like bract." Blossoms in June.

The seeds are round, like a pea, grayish, ripening in October. When ready to fall they can be beaten down with a pole. After drying a few days, they should be planted in rich soil. They can also be propagated from shoots that spring up around the trunks of the forest tree, by shoveling soil upon them, and in two years they are well rooted. Layering is a successful method.

The wood is white and tender, clean and beautiful when polished and varnished. It is used for boxes, carriage bodies, chair-seats, and is growing popular even for floors.

The flowers of the lindens are special favorities for bees, and the honey thence extracted is classed as of the best quality. It pays to raise them for honey alone; but other commercial values are so great we cannot afford to neglect planting extensively our basswood in every part of the State.

ASH FAMILY.—*Oleaceæ.*

WHITE ASH.—*Fraxinus Americana.*

Frequent on the banks of our rivers and lakes, and on the edges and acclivities of swamps, scattered also on high drained grounds. A fine tree, straight trunk, often undivided to a height of 40 feet or more. Bark is deeply furrowed on large stalks, checked into small squares one to three inches in diameter. Leaves opposite on their stalks, the green color on their upper surfaces, finely contrasting with the white underneath.

It is easily propagated from seeds, and abounds in all the woods of our State. It is a favorite domestic tree, and hence is cultivated in all sections of the commonwealth. In the Devils lake woods it occupies large areas, and there ranges from 60 to 85 feet in height and has a diameter of 1 to 2½ feet. It is the best tree for fuel we have in North Dakota.

The cylindrical seeds are about an inch long, gradually flattening into wings slightly notched on the ends. They grow in bunches four or five inches long. Ripe in October.

In common with all the other ashes, its thriftiness and value are affected by the soil in which it is planted to a remarkable degree. In rich soil its wood is apt to be brittle; is tough and reedy in sandy soil, greatly enhancing its value. When the wood is perfected, it is reddish; sap-wood is white. It is used for carriage shafts, wheel felloes, sledges, wheelbarrows, scythes and other tool handles, butter boxes and firkins, sieves, wooden bowls, oars, barrels, etc.

Prof. F. L. Budd, of Ames, Iowa, says: "A grove of 10 acres thinned to six feet apart, containing 12,000 trees, at 12 years were eight inches in diameter, and 35 feet high, the previous thinning paying all expenses of planting and cultivation. Ten feet of the bodies of these trees were worth, for making bent stuff, etc., 40 cents each, and the remaining top 10 cents, making a total of $6,000 as the profit of 10 acres in 12 years, or a yearly profit of $50 per acre."

J. Jay Smith reports that the leaves and branches of the white ash "are said to be poisonous to serpents and the leaf to cure their bite. An ash leaf rubbed upon the swellings caused by mosquitoes removes the itching and soreness immediately."

RAD ASH.—*F. Pubescens.*

In the woodland regions it is quite extensive; "velvety shoots and leaf stalks; fruit flattish, two-edged seed-bearing body acute at the base, the edges gradually dilated into lance-linear or oblanceolate wing." Leaves 12 to 15 inches long. Wood esteemed equal to that of the White ash.

BLACK ASH.—*F. sambucifolia.*

Buds of a deep blue; young shoots a bright green in early spring. No calyx in the fertile flowers. Leaves have peculiar appendages on each side of their base, when first unfolding, but dropping off in a few weeks. In their full estate, they are 12 to 15 inches long, "composed of three or four pairs of leaflets with an odd one." When bruised they emit an odor like the elder. Seeds are flat, bunched and winged. Ripen in the fall. Bark a duller hue than that of the White ash, and less deeply furrowed. Ripe wood of a fine texture and brown complexion; tougher and more elastic than White ash, but less durable. Growing more and more popular for strong structures and furniture. More than any other species it develops gnarls attached to the body of the tree. These excresences have singular undulations, looking sometimes like clusters of little vines arranged in bowers. The wood of such is very beautiful when polished and varnished. The ashes of this tree are rich in potash. Take it all in all it is deserving of special attention. Found in various sections of North Dakota.

GREEN ASH.—*F. viridis.*

The most frequent of all our ashes. Has the properties of the Red ash, but is a smoother and smaller tree. Leaves vary from 6 to 15 inches long. "The seeds of the green ash are frequently mistaken for those of the White ash, and sold as such by dealers. They can be readily distinguished apart, however. The seed of the White ash has a long wing, and the seed pod itself is elongated. The Green ash seed has a much shorter wing and the seed pod is not more than half as long as that of the White ash."—*Hodges.* Ripens in the fall. Though not a large tree, it will double its natural size by cultivation. "A true pioneer of the forests," says Dr. Warner, of Ohio, "soon to be planted on the plains, it spreads naturally into the native grass, and struggles through the prairie herbage that would destroy other trees." This tree doubtless would be found to do well on our extensive plains.

BETULACEÆ.—BIRCH FAMILY.

The natural climate of the birches is in the northern parts of the eastern and western continents. The cold is as natural to them as to the white bear of the Frigid zone. Below the 43rd degree, north latitude, they dwindle into mediocrity. Michaux avers that there are as many species of the birch found in the United States as in

Europe; "and, from my own observations on the comparative properties of their wood, the advantage appears to lie wholly on the side of the American species."

J. Jay Smith, translator of Michaux, says the Earl of Huntington calls the birch an amphibious plant, "as it grows on rich or poor, wet or dry, sandy or rocky situations, nor refuses any soil or climate whatever."

It finds a home in the different woods in our State, the Picture Park being its favorite habitat. It is highly appreciated for its many excellent qualities, and hence is cultivated as a domestic tree by many of its admirers.

Most of the birches ripen their seeds in September or October. The birches follow in the wake of the forest fire, springing up as if by enchantment. In the woodlands of Europe, 15 pounds of seed is sown upon an acre. A common method there has been to harrow up the ground fine and mellow, in the late fall, and cover by dragging over it a brushwood drag. Like all other forest seeds and plants, the birches at first need a shading against hot and dry suns. If the design is to sow in an open field, a good way is to mix it with winter rye, and treat as described, making the cereal crop pay on the forest expenses. This method would do on our woodland territory, but is questionable as to the success on the windswept prairie.

In the extreme northern part of Europe, the wood is used for the manufacture of almost all the implements of husbandry—wheels, bowls, plates, spoons, chairs, etc. In our country it is beginning to be better appreciated than to use it up for fuel. Some of its species, the Canoe birch especially, has a wavy grain, beautiful for furniture. In Sweden, Norway and Finland much importance is attached to the bark from which is made pans, baskets, sandals and the like. The rustic people there make soles of it, and fix it in the crown of their hats for protection against dampness. The Laplanders use it in making the reindeer skin waterproof. In Russia the bark of large trees is burned in kilns or furnaces and thence an empyreumatic oil is obtained with which a leather is prepared which is highly esteemed for durability. When young and tender the leaves are given to domestic stock, and families use them as a substitute for tea, and dyers employ them in dying wool to a yellow luster. In the spring the sap of the birch is copious and is often boiled down to a delicious syrup.

Susceptible to so many practical uses, and being so hardy and pretty, the birch deserves special attention. Speaking of its beauty, "Emerson remarks," says J. Jay Smith, '"that no trees are more distinguished for their light and feathery foliage, and the graceful sweep of their limbs, than the birches; no family affords such a variety of aspect.'" Certainly no tree on our lawns is more attractive than the Weeping Cut-Leaved birch—a European hybrid.

BLACK BIRCH.—*Betula cuta.*

This is known as "Mountain Mahogany" in Virginia, and Sweet and Cherry birch in New England and Canada. It is at its best in deep, loose, cool soil, and there will grow 60 to 70 feet in height and from two to three feet in diameter. It is one of the earliest trees to unfold its buds. The flowers appear along with its leaves which resemble those of the cherry. "The leaves," says Dr. Gray, "are oblong ovate and somewhat heart-shaped, sharply doubly serrate all around." They are dotted with white and so are the smooth young shoots. Bruise them and they emit a sweet odor, and will retain this quality when dried and preserved. It matures its seed about the first of November. The bark is smooth and grayish, and much resembling that of a cherry tree. "When freshly cut, the wood," says Michaux, "is of a rosy hue which deepens by exposure to the light. Its grain is fine and close, whence it is susceptible of a brilliant polish; it possesses a considerable share of strength." It is sought for tables, beadsteads, panels, arm chairs, etc. It is a rapid grower. Its mahogany-like wood, its beauty of foliage, its odor of flower and leaf recommend it as a central figure in the park and lawn. It abounds in the Turtle mountains and other woods of North Dakota.

YELLOW OR GRAY BIRCH.—*B. cutea.*

Dr. Gray reports the bark of the trunk as "yellowish gray and somewhat silvery, separating in filmy layers." Sometimes the epidermis is rolled backward at the ends, attached only in the middle. Its golden yellow and graceful foliage render it very conspicuous in the woods. Its fruiting catkins are short-oblong, the scales visibly downy under the lens. The seeds beneath the scales are small-winged, ripening about the first of October. The wood is not as deep-shaded as the black birch, but is strong and handsome; makes good ox-yokes and frames of sledges. The bark is used in tanning. Take it all in all this tree possesses many merits and is deserving of special favor.

RIVER, OR RED BIRCH.—*B. rubra.*

This species is rarely found away from limpid streams and rivers. In middle age, when about 10 inches in diameter, its epidermis is reddish or cinnamon colored. Like that of the Canoe birch, it can be divided into sheets. Ample in summit, thick branches, twigs long, flexible and pendulous. Leaves about three inches long, two broad; whitish beneath, green on the upper surface, edges deeply denticulated, pointed at summit. Seeds ripen in June.

The wood is nearly white, both in the sap and heart. Like that of the Juneberry, it is marked longitudinally by red vessels, intersecting each other in the different directions. Makes good trays. From its twigs stable and street brooms are manufactured. Its saplings are used for hoops to a good advantage. Unlike other birches it enjoys intense heat, but while it adapts itself to sunny elements it thrives in the north when protectingly environed.

PAPER, OR CANOE BIRCH.—*B. papyracia.*

Its limbs are slender and flexible, or a shiny brown and white dotted, while the body of the tree, especially when young, is as white as the wintry snow, which it delights in. It is more papery than the so-called White birch of less size. The leaves are of middle size, unequally denticulated, ovate, heart-shaped, dull beneath, dark green above; oblong, downy, short-stalked catkins; wings of fruit broad, ripening toward the middle of July.

The sapwood is perfectly white. When first laid open, its heart is a reddish blue, glossy grained; speedily decays when subject to the extremes of dryness and moisture. It makes superior tables. Some sections of it are as beautiful as mahogany, and is much sought for special embellishment. Like its kin, the White birch of Europe, its bark is used for various purposes. Before we had tarred paper, it was laid immediately beneath the shingles to the roofs of our houses. Pretty baskets are made of it, and fancy boxes and portfolics. From it the Indians construct berry boxes and sap buckets, and canoes, so light that they are easily transported on the shoulders from one lake or river to another. A most valuable tree this. It likes the acclivities of hills, and also flourishes in the alluvial bottoms. Vast areas of the Turtle mountains are covered with this tree.

The panel work in the North Dakota division of the Woman's Building at the World's Columbian Fair was made from the beautiful woods of this tree, procured in the Picture Park.

MAPLE FAMILY.—*Sapindaceæ.*

STRIPED MAPLE OR MOOSEWOOD.—*Acer Pennsylvaniana.*

It is a small, pretty tree, having, as Prof. Gray describes, "light green bark, striped with dark lines, large thin leaves, finely sharply serrate (toothed) all around, and at the end three sharp and very taper-pointed lobes, slender hanging racemes (flower clustered) of rather large green flowers, and fruit with diverging wings." Attractive at all seasons. "One of the earliest trees to feel the approach of spring." Ripens its seed about the first of October.

SUGAR MAPLE.—*A. Saccharinum.*

Known also as Hard and Rock maple. It is a tree of the north, mostly abounding in the states and Canada between the 43d and 49th parallel. It likes to live on the mountain sides, on the crest of hills, in cold, humid valleys, but everywhere demands fertile soil. Will attain 70 to 80 feet and proportional diameter. Its bark is grayish white.

Leaves about five inches broad, varying in length according to age and vigor. They are attached opposite each other on long stalks, palmated (like the hand with outstretched fingers), five-lobed, bright green above, whitish underneath. The first touches of autumnal frost turns them red. "Calyx bell-shaped and hairy-fringed."—*Gray*. "Flowers small, yellowish, suspended by slender, drooping peduncles. Seeds contained in two capsules united at the base and terminated by a membranous wing."—*Michaux*. Seeds ripen in October, but mature only once in two or three years.

When first cut, the wood is white, but when long exposed to the light assumes a rosy tinge. Grain is close and fine; silken-lustered; strong and heavy; is not durable as the oak; quickly decays in moisture. It makes good axle-trees, wheel-spokes, sled runners, chairs, desks, etc. The sugar maple is not native to North Dakota, but it and the soft maple are grown to some extent as domestic trees.

WHITE MAPLE.—*A. Dasycarpum.*

Also called the Soft Silver and River maple. It blooms early; flowers greenish; destitute of petals; fruit woolly when young, soon smooth, developing to oval-shaped seeds with great diverging wings. Ripen in June. Trunk low and stalky; many limbed; divergent, spacious head, opening well to the sunlight. Its foliage is magnificent. Leaves deeply five-lobed; silvery white and downy beneath; densely green above. Note them as they tremble in the wind, aflame with their brilliant white and green—a life-moving picture of light and shade. Its sap is saccharine, yielding but half the sugar product of the Hard maple—measure for measure as it flows from the trees. The wood is white and fine-grained, soft and light; serves well in cabinet making, and is growing more and more in favor; makes the best of charcoal. Rightly managed is a success on our prairies, but needs the protection of other trees, for its limbs are apt to split down in our heavy winds. Pruning of this tree should be on its laterals, carefully preserving the central stem.

THE BOX ELDER, OR ASH-LEAVED MAPLE.

Negundo Aceroides.

The Box Elder is one of our reliable pioneer trees and growers, in all the woods of our commonwealth, and it is surely one of the most serviceable of the family trees. It will stand more ill uses and live than any other tree in the West. Properly cared for, it makes a tree, straight, well proportioned in limbs and head, with spreading, symmetrical branches. It has strong friends because of its good habits and qualities. It makes a beautiful shade tree and it is cultivated as one of the leading domestic trees of the State. It sometimes attains two to three feet in diameter. It is characterized with green twigs, drooping clusters of small greenish flowers coming out earlier than the leaves. Even when growing in our native woods, it tends to a broad head with dense foliage; hence one of our best shade-needing trees. It sprouts largely from the crown of its roots, interlacing among its companions, climbing to the light; and therefore forms a very compact and solid wind-break. This and the ashes and elms belong in the list of the reliable trees of the prairied West. As yet it is not much used in the manufacturing arts. The seeds are encased in long shells, protruding into rudder-like wings. Sugar and syrup of excellent quality can be made from its sap.

WALNUT FAMILY.—*Judlandaceæ.*

BUTTERNUT.—*J. cineria.*

Otherwise called the Oil nut and White walnut. It is a national tree, belonging mainly in the north. It generally branches out at a small height, mostly horizontal, forming a large tufted head in fine balance. When young it resembles the Black walnut, but they are unlike in maturity—especially in the woods—the Butternut being light in weight, of little strength and reddish in color, while the Black walnut is heavier, stronger and of a dark color. No panels are prettier than the Butternut. It is a very popular wood for furniture and house finishing. Vegetates early in the spring. Each leaf has seven to eight pairs of leaflets with a terminal odd one. They are lance-like, toothed and slightly downy. The barren flowers in single catkins are attached to the shoots of the preceding year; the fertile flowers on shoots of the same spring, and at their extremes. The fruit is commonly single, oily and palatable. The nut itself is hard, oblong, round at the base, pointed at summit; the surface furrowed irregularly and rough. The bark possesses medical properties, regarded as the best of cathartics. The tree is hardy; will do well even on the prairie under protection of other trees. Is a rapid grower. Ripens its seeds in the early fall; should be planted just before the ground freezes up for winter.

BLACK WALNUT.—*J. nigra.*

With protective environments can be made a fair success between the 45th and 47th parallel. Leaves about 18 inches long; number of leaflets about same as the butternut. The set relation of the flowers are the same. Fruit is rounder than that of the butternut;

odoriferous, uneven on surface, appears at the extremity of the branches sometimes seven to eight inches in circumference. Husk is thick. Nut is hard, compressed at sides, grooved into deep furrows. Pith is in plates, sweet, agreeable, but not equal to that of the European walnut. In other respects our American Black walnut is superior to the European. Seed ripens in the fall. The bark on old trees is deeply furrowed, thick and blackish. "The duramen of the wood is compact and heavy, of a deep violet color surrounded with a white alburnum."—*Wood.* On exposure to the air the duramen (ripe wood) becomes nearly black, and the alburnum (sap) speedily decays. Very strong and tenacious; does not warp or split when thoroughly seasoned. Admits of a fine polish. The curly walnut is incomparably beautiful.

It is used in naval architecture, in cabinet work, in chairs, in furniture, in musket stocks, etc. The husks of the fruit make good dye for woolen stuffs. I have used this wood, also oak, ash, cottonwood, poplar, elm, basswood and others in the manufacture of a long line of chairs, at our manufactory in Wisconsin. All things considered, it is one of our most valuable trees and should be extensively planted. It commands a high price in the market.

HICKORIES.

These belong to the Walnut family.

The bark on mature trunks is very shaggy, having rough strips. Like that of the Yellow birch, the narrow plates bend outward at the ends, but adhere in the middle. Amid the shade of other trees the trunk is destitude of branches for nearly three-quarters of its length, and nearly uniform in size. Will grow 80 to 90 feet high and yet be not over two feet in diameter. The fruit ripens in the early part of October. Late fall planting is the more successful way of management. It is round, divided into four seams, which readily open at maturity. The nut in this quarto-divisional epicarp is comparatively small, having four angles corresponding with the divisions of the thick husk. The kernel is sweeter than any of the American walnuts except the Pecan nut. The Shell-bark hickory nuts bring a good price in the market. Like that of all other hickories, the wood is elastic, strong and tenacious. Has fine rift. It is used for the keels of vessels, hoops, whip-stocks, axe-handles, etc. The tree endures the most intense cold. Why is it not more largely planted?

WILLOW FAMILY.—*Salicaceæ.*

Nearly all our willows naturally grow in humid situations, along our water shores, where they serve the useful purpose of preventing the erosion and waste of soil. The bark of most of them contains a medical property about as effectual in intermittent fevers as the Peruvian bark. Botanists find the willow family as among the most difficult to discriminate. The distinction obtains principally in the variability of their stamens, leaf appearances and seed vessels. Their flowers are generally diœcious, that is, a class of plants whose sex-flowers are on two different individuals, as opposed to monæcia, with two sorts of flowers on different parts of the same plant. Their seeds, developed in catkins, are very numerous; hence the willows multiply very rapidly.

BLACK WILLOW.—*Salix nigra.*

A river tree, growing thirty or more feet high; usually divides into large limbs at a short distance up the trunk. Leaves long and narrow. A decoction of the roots is pronounced a good purifier of the blood.

The Myrtle willow, *myrtiliodes*, has its merits, rare southward, frequent northward, even north of Lake Superior. A good protection against polar winds.

Long-Leaved willow, *S. longifolio.* There seems to be some confusion among botanists as to the identity of this willow. Gray mentions it "as a low shrub or a low tree." Nuttall, dating from his observations in Oregon, speaks of it as a large tree: "No willow on the American continent presents so remarkable and splendid an appearance."

ALMOND-LEAVED WILLOW.—*S. amygloides.*

Abounds in the Red River valley and thence eastward. It attains a tree-like size, peculiarly attractive. Prof. M. B. Webb, in Wheeler's reports of surveys west of 100th meridian, thus credits it: "The broad leaves, being supported by long and slender petioles; are moved by the slightest breeze, displaying in rapid fluttering succession their conspicuous white under surfaces, thus producing an effect in striking contrast with the changeless, soft light reflected from masses of the foliage of the *S. nigra* when swayed gently by the wind."

WHITE WILLOW.—*S. alba.*

Originally from Europe; much cultivated; is very valuable on the prairie for shade and protection from the wind; hardy and reliable; grows rapidly; yields good fuel; pays well to raise it. Propagated from seeds or cuttings. The White willow abounds in all parts of our State, attaining large dimensions on the Red, the Missouri, and in the Turtle mountains. It is one of the very best domestic trees and is cultivated extensively.

THE DIAMOND WILLOW.

SALIX.—*Cordata.*

This hardy vigorous tree is a habitant of most of our woods. It grows abundantly in the river bottoms of the Missouri, the Red and the Mouse rivers. It is used extensively for firewood.

POPLARS.

The name *Poplar* to this tribe of trees was suggested from the historic fact that, "in ancient times, the public places of Rome were decorated with rows of Poplar, whence it came to be called *arbor populi,* as to being a tree peculiarly appropriated to the *people.*

THE SILVER OR WHITE POPLAR.—*Populus Alba.*

This tree is one of the most valuable trees to be found in the forests of our State. All North Dakota should be proud of it because it is an every day, practical, useful tree, supplying fuel, fencing and building material. In six years, so rapid is its growth, it attains a height of 15 to 18 feet, when it makes good fencing. It has the best of habits, possesses beauty in every part. It covers hundreds of acres in the Picture Park and is found in all sections of the commonwealth. It is propagated from suckers, cuttings and seeds. It makes a handsome tree for the home yard, the school yard, and the park.

The first Sylvatan celebration in North Dakota took place on last Arbor day, in May, 1894, at Church's Ferry, and trees of this kind were set out and dedicated, and are now in a thrifty condition in the village school yard.

Carried by winds, the seeds of this favorite tree have found lodgment in the soils of our prairies, and since the exclusion of fires, millions of these hardy trees have appeared, making large groves in many places.

They generally spring up in sloughs, where water stood in the pioneer days of 1883-'84.

Others besides our citizens admire this tree. The Iowa Forestry Annual says:

"The size which this tree, the silver poplar, will reach on the prairie in 10 years is a matter of wonder and surprise. It is probable that we have no tree with valuable wood that will reach saw-log size as soon as this. Like the elm, the intrinsic value of this tree has been over-looked. Let us enumerate:

(1) It propagates from cuttings of any size, even more readily than the willow.

(2) It is valuable for about the same uses as the famous tulip tree (*Liriodondroa tulipifera*), of Ohio. It makes very

superior flooring, wainscoating and even finishing lumber for houses. The boards used for siding, or for fencing, are vastly superior to any of the poplar family, except it be the yellow cottonwood. For dry goods boxes, bowls, trays, carriage bottoms, trunk making, chair seats, etc., the wood is counted in Europe superior to pine and whitewood.

(3) When thickly planted, it runs very straight, and the poles cut in thinning can by utilized by nailing on posts for fence, for rafters, sleepers, etc., as with aspen. As with the latter, the trees for this use should be cut in summer, and peeled, when they are quite durable if kept from the ground.

AMERICAN POPLAR OR ASPEN.—*Populus tremuloides.*

Abounds especially northward. This small tree blossoms the latter part of April, appearing ten or twelve days before the leaves. The catkins, springing from the extremity of the branches, have silky plumes on them. Leaves are about two inches broad, narrow at the summit, dark green in color; in the spring red-veined; on young shoots, large, heart-shaped and pointed; on older stocks becomes round, irregular toothed. Having such shapes, and suspended on long petioles, they tremble in the gentle breeze.

LARGE ASPEN.—*P. grandidentata.*

Less common than the preceding, but a larger tree. Has a straight trunk, smooth greenish bark, rarely cracked; branches scattered and few, foliaged at their extremities. Leaves nearly round, smooth on both sides and bordered with large teeth. Catkins about six inches long, appearing in the infancy of the leaves, then thickly coated with down.

BALSAMIC POPLAR, TACAMA[illegible]AC.—*P. balsamifera.*

A middle sized tree, "has round or scarcely angled branchlets, very glutinous and pleasantly balsamic strong scented bud-scales, and ovate, or lanceolate gradually tapering leaves."—*Gray.*

The hardest of the poplars; not so pretty as the other species. It extends far into the north. The greater part of the drift-wood is this poplar found on the shores of the Arctic ocean. "Pallas states," says the translator of Michaux, "that the grouse and other birds of that family that feed on the buds of this poplar during the winter, have their flesh imbued with a grateful balsamic flavor."

BALM OF GILEAD—*P. balsamifera, var. candicans.*

Trunk smooth-rifted, greenish bark, dark green foliage, tufted; branches irregular. Leaves three times larger than the preceding, and heart-shaped. The tree is literally saturated with water; wood requires a long time to season. Roots spread inveterately. The balsamic property is healthy and emits a pleasant odor.

This variety of the poplar family is native to the Picture Park where it grows extensively, attaining 60 to 70 feet in height. It also abounds in other parts of North Dakota. It is easily propagated from cuttings. It is at home in many yards of our State and it is a desirable tree in many respects, and should be more extensively cultivated.

WHITE OR SILVER LEAF POPLAR—*P. alba.*

European originally, now growing spontaneous. It is a fast grower and massive. "Spreading branches, roundish, slightly heart-shaped, wavy-toothed or lobed leaves, soon green above, very cottony beneath."—*Gray.*

THE YELLOW COTTONWOOD—*Populus monolifera.*

The yellow cottonwood is one of the poplar family, and no member of our whole sylva is more deserving of attention.

It is a rank, rapid grower, upright and regularly shaped. In all its parts it is symmetrical, and from base to crown displays beauty that makes it a favorite tree for public places and the country at large. It is a surprise to discover how rank and fast it increases under fair favorable circumstances, growing near three feet each year in height and over one inch in diameter. I know of trees of this kind, found in Ramsey county, which at the end of six years were nine inches in diameter one foot from the ground and 35 feet high. Many groves of this tree in the same county stand a height of nine feet at the end of three years from the time of planting. Often these trees, growing in good soil and properly tilled, reach the dimension of 15 to 20 inches in eight or ten years with corresponding height. Indeed it is contended by many of the most intelligent foresters and tree growers in the nursery and on the farm that the cottonwood is without a rival in the rapidity of its growth, even outstripping that of the white willow. And it also makes good, sound and compact wood. It has many commendable habits and scarcely, if any, poor ones, and in all places and under all circumstances it is the pride of the young and old, "a thing of beauty and a joy for ever." It has all the characteristics desirable in a prairie tree, where it is extensively cultivated with most gratifying success.

This tree is discovered in the native forests, scattered over a vast area of the Union. It is found in almost every belt of timber and woods in our State. It rises high along all or nearly all the branches and rivers within our borders. Upon the hill lands of the Turtle mountains it grows stately and strong. By the fair

Red river of the North and its many feeders it towers and waves aloft amidst its fellows, and by the shores of the broad Missouri, the great commercial artery of our fair State, there it flourishes without limit or bounds. In all these places it presents large trunks and rises 70, 75, 85, 95 or more feet. I have found numerous cottonwoods on the Red viver measuring 18 and 21 feet in circumference, with a heighth at least of 100 to 120 feet. This tree is the pride and glory of the renowned Sylvatan Park, from whence a fine specimen was sent to and exhibited at the great World's Fair at Chicago in 1893. The catkins or tassels are long, flexible, pendulous. Seeds enveloped in white plumy cotton; buds resinous, aromatic and agreeable. When the seeds are ripe, in June, the winds bear their cottony down in all directions, lodging where they can. M. De Foucault, a French botanist, correctly says: "The leaves are deltoid, or trowel-shaped, approaching to cardiform (heart-shaped), always longer than they are broad, glabrous, smooth, having no hairs and unequally toothed; the petioles are compressed and of a yellowish green, and two glands of the same color as the base; the branches are angular, and the angles form whitish lines which persist even in the adult age of the tree."

Its heartwood is of a yellowish color, not much dissimilar to the tulip tree. It is classified as soft wood, and as such it makes excellent fuel, and has a ready sale in the market, commanding fair prices. Its durability is a commendable feature. It makes first-class fence posts, boards and rails. An instance is given by Judge C. E. Whiting, of Monona county, Iowa, where he procured cottonwood posts from trees of the Missouri bottoms, which, on resetting after a use of 23 years, nine-tenths of them were found in a fair state of preservation. It is even claimed that this tree furnishes better fence boards than pine, because a tougher and stronger dimension stuff and frame material manufactured from this variety is more serviceable. And its shingles and siding endure well, keep their place and look as well as good pine. This tree is also used for many other purposes upon the farm, in the workshop and the factory.

Nature is often prolific with her productions. This is made manifest by the many millions of seeds that annually grow upon these trees from which they are scattered broadcast over the land, where, taking root, they spring up as seedlings, while many more millions of seeds are destroyed by exposure to the sun and wind. Sometimes, in October, on lands broken in the previous June, many thousands of seedlings have been seen growing from seeds carried there by the winds from the trees three or four miles away.

The cottonwood blossoms in early spring and ripens its seeds before the heat of summer intervenes, usually in the early part of June. The seeds are encased in elongated catkins from which they escape, surrounded by a light flocculent or cottony material giving them a bouyancy which results in their wide diffusion by the winds. The seeds are small and cannot be economically gathered from the ground, hence they are often harvested from the tree just at the time when the catkins or pods begin to open in ripening. At times the fruitful twigs are broken off and placed in a dry room, generally an airy chamber, where the seeds are allowed to mature and separate, as in nature. If gathered from the tree or ground by hand, they should not be allowed to heat but be spread out thin in a dry place well removed from the influence of the hot sun and the wind, and sowed when the pods open.

If the seeds lie upon the ground for even a few hours they lose their germinating qualities, for this reason they should be sown immediately after maturing. The seeds should be lightly covered. Sow in beds consisting of rich, deep and well pulverized soil, and covered by scattering fine soil over them. Firm with a board, hoe or light roller. A bushel contains, it is computed, near 7,000 seeds.

This has been found to be a successful way of planting: Cut off the seed laden branches of the trees about the time of ripening, transport them in wagons to the country, and place the twigs cut therefrom in deeply plowed furrows, with no dirt turned on. There the seeds ripen and drop from the pods to the ground where they vegetate and grow. Thus acting in harmony with natural inclinations, or the natural law of propagation, many thousand of seedlings are easily produced.

Experience proves that planting close works favorably. Judge C. E. Whiting, of Iowa, a gentleman thoroughly versed in sylviculture, was accustomed to plant 4,356 trees to an acre. This insured straight and symmetrical forms and tall growth, with few or no side branches.

Immense numbers of these young trees of all sizes are to be found on the bottom lands of the Missouri river; enough to plant all the prairies of our State. These are generally procured in the fall as spring freshets usually cover the lands. In favorable localities an active man can procure from 15,000 to 20,000 of the seedlings in a day. Numerous parties in the Missouri towns make it a business to furnish the farmers of the State with these trees. Many thousands are shipped each year from Bismarck. The cottonwood seedlings from all woods of the State, as a rule, are hardy and reliable.

The white willows and box elders are much valued trees, but given sufficient moisture, protection from unseasonable frost, proper soil and needful care and cultivation—conditions absolutely necessary for all trees—the cottonwood, I am free to say, will prove to be the most desirable and profitable tree that can be raised in North Dakota.

Then make welcome the cottonwood—the pioneer of our forestry—and all its sister trees—and develop them with intelligent care, when our wide, bleak plains will put on a foliage of wavy green, delightful to the eye and dear to the heart, to break the force of the wind, husband the moisture, promote favorable meteorological conditions for grain and fruit, increase wealth and values and adorn the land as the sacred abode of an intelligent, contented and happy people.

THE BLACK COTTONWOOD.

The black cottonwood is a fine tree with narrow, willow-like leaves. Found in South Dakota. This curious tree looks more like a willow than a cottonwood, and would make quite a novelty in the ornamental grounds.

THE HACKBERRY.—*Celtis Occidentalis.*

This tree flourishes extensively in the Devils lake timber and in the forests of the Red and in other localities of the State. It has no bad habits and many good ones. It grows tall and straight, turning out well proportioned branches, and displays beauty in every part. It is found in many yards and on the farms. It is deserving of extensive cultivation.

SOFT MAPLE.—*Acer Dasycarpum.*

The soft or silver leaf maple is a rapid grower, generally healthy and sound. If well cultivated it produces a large amount of fuel of good quality in a few years. If manured it will, it is claimed, grow more rapidly. It makes a desirable shade tree, and as such is planted to some extent in our State. It is a favorite, being symmetrical and attractive. It is sure to show good qualities if planted close in groves, making handsome straight trees with smooth, healthy bark and a rapid growth. By the pressure of strong winds it is liable to split down when standing alone. This beautiful tree is a native of our State, growing in the woods of the Red river and in other parts of the country.

THE PINE, SPRUCE AND CEDAR.

These trees, limited in number, abound in the neighborhood of the Little Missouri and at a few other points in our realm. These evergreens find friends, for they add much to the brightness and attraction of the home and field.

THE JUNEBERRY AND PLUM.

These trees never attain large size, being from 10 to 25 feet tall, but for fruit purposes they are of great value to our State. They grow in all sections of the State, and have a place in many of our gardens and on our farms. The annual crop of these trees in our State would fill many box cars. It will pay handsomely to cultivate them extensively.

HAZEL NUT.—*Carylus Americana and rastrata.*

Common throughout the State and yields very large quantities of nuts, which are extensively used by the people, especially by the young.

HIGH BUSH CRANBERRY.—*Viburnum opulus.*

Native, vigorous and hardy; grows from 4 to 10 feet high; white flowers in June; clusters of yellow and red edible fruit hanging on into winter. Grown from seed, cuttings or layers. Very bountiful in North Dakota.

PRICKLY ASH.—*Zanthoxylum Americana.*

Common, perfectly hardy; makes an impenetrable hedge. Autumn seeds. Grows in abundance on the Red river.

BUFFALO BERRY.—*Shepherdia argentea.*

Give it a proper place and it will grow from 10 to 15 feet high; found along the water courses of Dakota and Montana; bears imperfect flowers before the leaves appear; leaves are silvery and pretty; difficult to secure pistillate plants, hence must have fertilization; fruit red, having one quite large seed; acid; makes a good jelly or sauce; hardy, and is used for hedges. Grows from seed. It makes excellent protection from the winds, as it is a fine hedge tree.

VINES AND CLIMBING SHRUBS.

Vines and shrubs constitute a part of the forests of all lands and are deserving of extensive mention, but want of space forbids. All the vines named below are found extensively in the woods of our State:

American Ivy, *Ampilopsis quinquefolia.* Native, strong, hardy; beautiful, bright crimson foliage in autumn. Surpasses all for covering porches, unsightly fences and decayed trees. Grown from cuttings, layers and seeds.

Bitter sweet, *Celastrus scandens.* Hardy, clean, conspicuous and pretty when covered with its orange-colored seed pods. Grown from seed or layers.

Wild Grape, *Vitis riparia.* Coarse but beautiful, covering dead trees or any unsightly object. Hardy anywhere; fragrant flowers. Excellent stock for grafting on the domesticated grapes. Grown from cuttings or layers.

Creeping Spruce and Creeping Cedar grow on the Missouri and its tributaries; Wild Hops and Bitter Sweet, Wild Cucumber and Wild Morning Glories adorn all our woods and forests.

THE UNDERBRUSH.

The underbrush adds much beauty and value to the forests. In North Dakota the following attractive varieties are found in all the woods: Hazel bush, filbert bush, high bush cranberries, black and red currants, gooseberries, red and black cap raspberries, dewberries, sand cherries, strawberries, wild rice, wild roses, ginseng, etc. And the mosses also assert their right to a place there.

OUR NUT TREES.

The native box elders, willows, ash, cottonwoods and basswoods prepare the way for a more valuable class of trees. The elm, ever healthy and sound, may always be called the "survival of the fittest." The nut trees are the most valuable woods that can be grown for manufacturing purposes, such as the white and red oak, the walnut, butternut and hickory. The nuts produced by these trees all have a marketable value, worth all the cost involved in their cultivation. Among these trees no one is more attractive in body, limb, leaf and blossom than the hickory, and probably this is the most difficult to raise in our State. They do commendably well in deep, sandy, light red soil, or yellow loam. Our prairie soil is not without adaptation to their growth. A clay sub-soil holding moisture, laying below at a depth of say two feet, will be found congenial. If the surface soil is composed of a heavy mixture of clay, the growth is stunted.

The safest way is to grow from seeds. Locality has much to do with the quality of the seed. The trees developed from seeds from southern states are not as hardy as from those grown in northern states, or from climates rigorous as ours. Our acorns ripen near the last half of September or the first part of October. Those falling from the cups or burrs are often worm eaten; the later falls are usually sound. Collect at once, and place in a dry shady place; spread thin on floor and stir frequently to prevent heating. There they will soon become brownish, leathery and wrinkled. Then mix them with sand, a little moist, and place in a cool cellar, and keep temperature at about 30 degrees above zero. Examine occasionally to see they do not sprout. It should be remembered that acorns will quicken their germs in the warm sun of the early fall days, and are then inclined to send their top roots into the ground. Thus it will be seen if planted before winter sets in, the frost may injure the germs. To be safe, keep them unsprouted till November, until you know the winter is at hand so the germ will not sprout until spring. Do you seek permanency? Then plant accordingly as the tree of a century. If, however, you want to raise seedlings for transplanting, keep the acorns in their seed bed.

NATIVE TIMBER OF NORTH DAKOTA.

As near as can be ascertained, the following estimate of the timber of North Dakota is approximately correct:

	Acres.
In private hands, per report of Department of Agriculture and Labor, (1891)	252,912
Additional timber in Bottineau county not enumerated (estimated)	44,000
Turtle Mountain Timber Reserve	183,840
Timber lands of Fort Totten Reservation (estimated)	25,000
Timber lands of Fort Berthold Reservation, per estimate of Major Murphy	40,000
Timber school lands, per statement of Hon. John B. Ogden, Superintendent of Public Instruction, Nov. 10, 1891	13,555
Total	559,307
Less part of the returns from Rolette county, which given in the list as private timber lands, are probably in fact government timber lands	100,000
Total	459,307

The area of cultivated or domestic trees in our State, per official returns made in 1891, was 26,242 acres, but the probable amount is near 40,000 acres, making our native and cultivated timber at least 500,000 acres.

NATIVE TREES, BUSHES, SHRUBS, CREEPERS AND VINES OF NORTH DAKOTA.

Common Name.	Botanical Name.	Diameter in feet.	Height in Feet.	Color of Seeds and Fruit.	Remarks.
Oak, white	Quercus Alba	1 to 4	50 to 70	Light brown	Many oaks in most of the woods of the State, the greatest number consisting of white variety. Its usual size is from 1½ to 3 feet in diameter. Blue oak found on Red.
Oak, red	Quercus Rubra			Light brown	
Oak, Jack	Quercus Nigra			Light brown	
Oak, black	Quercus Tinctoria			Light brown	
Oak, blue		½ to 1	20 to 30	Light brown	
Oak, bur	Quercus Macrocarpa	1 to 1½	15 to 25	Light brown	
Ash, white	Fraxinus Americana	1 to 2½	40 to 75	Dark brown	Fine varieties, mostly white, grow on the Red and its branches and in the Devils lake woods.
Ash, black	Fraxinus Sambucci folia			Dark brown	
Ash, green	Fraxinus Viridis			Dark brown	
Elm, white or rock	Ulmas Americana	1 to 6	60 to 85		The elm grows to an immense size in the woods of the Red and its branches, and in the Devils lake woods.
Elm, red or slippery	Ulmus Fulva				
Elm, swamp or piss					
Elm, cork	Ulmus Racemosa				
Birch, white	Betula Populi folia	1 to 2	60 to 75		Large sized birch grow extensively in the Turtle mountains.
Birch, yellow	Betula Excelsa				
Birch, black					
Birch, canoe	Betula Popyracea				
Maple, white, silver or soft	Acer dasycurpum			Straw color	This tree, the white, silver or soft maple grows on the Red river.
Hackberry	Celtis Occidentalis	1 to 1 1-6	50 to 70	Purple	The hackberry is found in the woods of Devils lake, the Missouri, the Red, and other points.
Box elder, or ash-leaved maple	Negundo Fraxini folium	1 to 2	40 to 60	Straw color	The box elder grows in all the woods of the State.
Willow, white	Salix alba	1 to 2	40 to 80		The willow flourishes in most of the woods. The Alaska is a scarce variety.
Willow, Alaska		1 to 2	50 to 80		
Willow, swamp					
Willow, red		1 to 3	6 to 8		
Willow, diamond	Salix Cordata	¼ to ½	15 to 20		
Willow, gray					
Poplar, white Poplar, silver-leaved Poplar, abele	Populus Alba	½ to 1¾	35 to 75		Large areas are covered with the poplar in the Turtle mountains and in the Devils lake woods. It abounds in all woods.
Poplar, yellow					
Poplar, quaking or American	Populus Tremuloides				Very large numbers of the Balm of Gilead abound in the woods of the Turtle mountains and some on the Mouse river.
Balm of Gilead	Populis Candicans	½ to 1¾	40 to 75		
Cottonwood, yellow	Populus Monolifera	1 to 7	60 to 125	Black	This valuable tree grows to large size on the Missouri, the Red and its branches, and it is found extensively throughout the State.
Cottonwood, white				Black	

NATIVE TREES, BUSHES, SHRUBS, CREEPERS AND VINES OF NORTH DAKOTA.—*Continued.*

Common Name.	Botanical Name.	Diameter in Feet.	Height in Feet.	Color of Seeds and Fruit.	Remarks.
Linden or Basswood	Tilia Americana	1 to 3	50 to 75	Gray	The Basswood attains a large size in the woods of the Red and its branches.
Pine, white	Pina Strobus	1 to 1¼			See article entitled Native Evergreens of North Dakota.
Spruce, Norway	Abies Excelsa	½ to 1			
Cedar, white American Arbor Vitae Cedar, red	Thiga Occidentalis	¼ to 1	15 to 20	Blue	
Ironwood	Olneya Tesota	2-12 to 4-12	15 to 25		
Prickly Ash		1-6 to ¼	2 to 15		
Dogwood		1-24 to 1-12	6 to 8		
Sumac		1-24 to 1-6	8 to 14	Red	
Kinnikinick		1-24 to 2-6	6 to 10		
Silverbrush		1-24 to 1-6	4 to 12	Gray	
Bushes—					
Jackbush or Badger	Eleagnut Argophylla	1-24 to 1-12 Small	4 to 10 1 to 5	Black	
Sagebush		1-12 to 1-6	1 to 4		
Snowberry		Small		White	
Rosebush		Small	2 to 6	Red	
Cattail		Small	4 to 6	Dark Brown	
Two, names unknown					
Fruit trees—					
Haw, black		1-12 to ½	10 to 20	Black	
Plum, red		¼ to ½	8 to 20	Red	
Plum, white				White	
Plum, yellow				Yellow	
Plum, purple					
Thorn		1-6 to ¼	8 to 15	Red	
Choke Cherry	Cerasus Virginiana	1-12 to ¼	6 to 20	Black	
Red Cherry	Cerasus Pennsylvanica	1-24 to 1-12	6 to 25	Red	
Black Cherry					
Sand Cherry		Small	1 to 1½	Black	
Buffalo or Bullberry	Shepherdia Argentea	1-12 to ½	4 to 18	Red	
Juneberry		1-12 to 1-6	6 to 18	Blue-black	
Nut bushes—					
Hazel bush		1-24 to 1-12	5 to 10	Dark brown	
Filbert bush		1-24 to 1-12	5 to 10	Light brown	
Fruit bushes—					
High bush cranberry		1-24 to 1-12	4 to 6	Red	

NATIVE TREES, BUSHES, SHRUBS, CREEPERS AND VINES OF NORTH DAKOTA.—*Continued.*

Common Name.	Botanical Name.	Diameter in Feet.	Height in in Feet.	Color of Seeds and Fruit.	Remarks.
Currant, black	....	Small	2 to 8	Black........	The small trees, bushes and vines and also the hazel bush are native to most of the woods of our State. The Juneberry and Plum are very plentiful in the Devils lake woods.
Currant, red	....	Small	2 to 3	Red........	
Gooseberry	....	Small	2 to 4	White........	
Raspberry, red	....	Small	2 to 4	Red........	
Raspberry, black cap	....	....	....	Black........	
Dewberry	....	Small	1 to 1½	Black........	
Wild rice	....	1-24	6 to 15	Gray........	
Creepers and vines—					
Creeping spruce	....	....	....	....	
Creeping cedar	....	....	1 to 1 1-6	Gray........	
Strawberry	....	....	....	Red........	
Wild grape	....	1-12 to 1-6	10 to 50	Black........	
Wild hops	....	Small	10 to 20	Brown........	
Bitter sweet	....	1-24 to 1-12	12 to 45	Scarlet........	
Creeping ivy	....	Small	6 to 20	Gray........	
Wild cucumber	....	Small	6 to 20	Dark gray....	
Wild morning-glory	....	Small	6 to 12	Black........	

This showing gives 50 kinds and varieties of trees, 18 bushes and shrubs and 10 creepers and vines, all of which are natives of our woods. The wild fruit constitutes 20 different kinds. Upon further investigation, probably more varieties will be found in our State.

PATIENT RESEARCH.

Much time and patient investigation has been taken by myself to obtain a knowledge of the trees, bushes, shrubs, creepers and vines mentioned in the preceding table, and hence the data or facts given may be considered reliable. Most of these forest productions have received my close and careful observation, whilst, in a few instances, it became necessary to rely upon the observations and testimony of other persons, whose statements are perfectly trustworthy.

CULTIVATED TREES, BUSHES, SHRUBS AND TRAILING VINES OF NORTH DAKOTA.

In addition to the domesticating of the before mentioned native trees, etc., the following varieties are cultivated on the farms, in the yards, gardens and the nurseries of our State, to-wit: Apples (winesaps and Pewaukee), crab apples (transcendant, hyslop and Siberian), plums (De Soto, rolling stone, etc.), peaches (cultivated in Burleigh county), white walnut (butternut), soft maple, hard or sugar maple, cut head weeping birch, golden Russian willow, Russian poplar, mountain ash, honey locust, Scotch pine, Norway spruce, balsam fir, red cedar, arbor vitae, osage orange, lilac, snowball, syringa, honey suckle, dentzia creeper, pyrus japanica, tame rose, southernwood, morning glory, trailing rose.

Thus we have in our State 67 varieties and kinds of native and other cultivated trees, 27 bushes and shrubs and 12 creepers and vines, and there are others not enumerated.

The *Russian poplars* consist of a great many varieties and they closely resemble the cottonwood. Some of these varieties are doing well in our State and are worthy of extensive trial.

NATIVE FOREST TREES IN VARIOUS SECTIONS OF NORTH DAKOTA.

There has been frequent inquiry as to the size of trees in North Dakota, and in order to enlighten those seeking information upon this point I deem it best to give the following list of trees in other localities.

NATIVE TREES OF THE PEMBINA MOUNTAINS AND THE PEMBINA RIVER.

Authority—A county official of Pembina county.

	Feet High.
Oak, white	20 to 35
Oak, jack	20 to 30
Ash	20 to 35
Elm	20 to 40
Birch	20 to 30
Box elder	10 to 30
Hackberry	small size
Cottonwood	40 to 50

	Feet High.
Basswood	25 to 40
Juneberry	6 to 10
Choke cherry	5 to 10
Red cherry	4 to 8
Plum	12 to 15
Thorn	8 to 10
Haw	10 to 15
Cedar, diameter, 4 to 5 inches	10 to 15

NATIVE TREES OF THE MISSOURI RIVER WOODS.

Authority—Oscar H. Will, nurseryman, Bismarck, N. D., and L. F. Burgh, nurseryman, Williamsport, N. D.

Kind of Tree.	Diameter.	Height in Feet.
Oak, burr	1 to 4 feet	25 to 60
Ash, white	1½ to 2½ feet	50 to 65
Ash, black	....	....
Ash, green	....	....
Elm, white	1 to 6 feet	65 to 85
Elm, swamp	1 to 6 feet	65 to 80
Birch, white	⅔ to 1 foot	30 to 40
Hackberry	....	....
Box elder	1 to 2½ feet	40 to 50
Willow, white	6 in. to 1 foot	50 to 80
Willow, diamond	3 to 6 in.	15 to 20
Willow, Alaska	1 to 2 feet	50 to 100
Willow, red	1 to 2 in	6 to 8
Poplar	½ to 1 foot	30 to 45
Cottonwood	2 to 7 feet	75 to 150
Spruce, Norway	....	....
Pine	4 to 9 in	15 to 20
Creeping spruce	....	1 to 2
Cedar, white	2 to 6 in	15 to 20
Cedar, red	2 to 6 in	15 to 20
Cedar, creeping	....	1 to 2
Haw, black	1 to 4 in	10 to 20
Plum, red	2 to 6 in	10 to 20
Plum, yellow	2 to 6 in	10 to 18
Thorn	1 to 4 in	4 to 12
Cherry, choke	1 to 4 in	10 to 20
Cherry, sand	....	1 to 1½
Buffalo berry	1 to 6 in	12 to 18
Juneberry	1 to 2 in	6 to 15
Cranberry, high bush	1 in	4 to 6
Hazel bush	½ to 1 in	3 to 10
Currants, black	....	3 to 4
Gooseberry, white	....	4 to 5
Raspberry, red	....	2 to 5
Strawberry, vines	....	....
Grape, wild, vines	....	....
Hops, wild, vines	....	....
Bittersweet, vines	....	....
Wild cucumber, vines	....	....
Wild morning glory, vines	....	....

NATIVE TREES OF THE TURTLE MOUNTAINS.

Authority—George Gilbert, Dunseith, N. D., and others:

Kind of Tree.	Diameter.	Height in Feet.
Oak, white	1¼ to 3 feet	50 to 60
Ash, white	1 to 2 feet	40 to 60
Elm	1 to 2 feet	40 to 50
Birch, white, yellow and black	1½ to 2 feet	60 to 75
Box elder	1 to 2 feet	30 to 40
Cottonwood	1 to 2 feet	65 to 80
Poplar	1 to 1¾ feet	60 to 75
Pine (small amount)		
Balm of Gilead	1 to 1¾ feet	50 to 70
Willow, white	1 to 1¾ feet	50 to 60
Willow, water	1 to 1½ feet	10 to 15
Willow, diamond	3 to 6 in	15 to 20
Juneberry	1 to 2 in	6 to 12
Choke cherry	1 to 2 in	6 to 12
Red cherry	½ to 1 in	5 to 10
High bush cranberry	½ to 1 in	4 to 6
Plum, red, yellow	1 to 2 in	6 to 15
Thorn and ironwood	1 to 2 in	4 to 10
Black haw	1 to 2 in	6 to 15
Hazelnut bush	½ to 1 in	4 to 12
Filbert	½ to 1 in	4 to 12
Rosebush		2 to 6
Badger bush		
Snowberry		
Raspberries		2 to 4
Currants		2 to 4
Gooseberries		2 to 4
Dewberries, vine		
Strawberries, vine		
Wild grapes, vine		
Wild hops, vine		
Bitter sweet, vine		
Wild ivy, vine		
Wild morning glories, vine		

NATIVE TREES OF THE MOUSE RIVER.

Authority—W. W. Barrett and citizens of Minot.

Kind of Tree.	Diameter.	Height in Feet.
Oak, burr	2 to 4 feet	50 to 60
Ash, white	1½ to 2 feet	40 to 50
Elm	3 to 5 feet	50 to 60
Box-elder	1 to 2 feet	30 to 45
Cottonwood, large size	....	....
Poplar, fair size	....	....
Balm Gilead, fair size	....	....
Willow, white	1 to 2 feet	20 to 45
Willow, diamond	2 to 6 in	15 to 20
Willow, water	1 in	10 to 15
Juneberry	1 in	8 to 18
Choke cherry	1 in	6 to 15
Red cherry	1 in	6 to 10
Plum, red	1 to 3 in	6 to 18
Plum, yellow	1 to 3 in	6 to 18
Thorn	1 to 2 in	5 to 15
Dogwood	....	....
Cedar, small size	....	....
Grape, wild, vine	....	....
Hops, wild, vine	....	....
Bitter sweet, vine	....	....
Currants	....	....
Gooseberries	....	....
Raspberries	....	....
Strawberries, vine	....	....

NATIVE TREES OF THE WOODS ON THE RED RIVER.

Authority—W. W. Barrett, Joseph Greenwood and Will Barnard.

Kind of tree.	Diameter.	Height in Feet.
Oak, white	2 to 3½ feet	75 to 85
Oak, red		
Oak, blue	1 to 1½ feet	20 to 30
Oak, burr		
Ash, white	1 to 2½ feet	75 to 85
Elm, rock		
Elm, red		
Elm, water	1 to 6 feet	70 to 90
Hackberry	1 to 1¼ feet	50 to 60
Box elder	1 to 2 feet	40 to 50
Willow, white	1 to 2 feet	40 to 65
Willow, gray		
Willow, red	1 to 2 inches	6 to 8
Willow, diamond	2 to 6 inches	15 to 20
Poplar, white	½ to 1 foot	40 to 70
Soft maple		
Cottonwood, yellow	1 to 3 feet	50 to 85
Basswood	1 to 3 feet	50 to 80
Haw, black	1 to 2 inches	15 to 20
Prickly ash	1 to 2 inches	10 to 15
Plum, red	1 to 4 inches	10 to 20
Plum, yellow	1 to 4 inches	10 to 20
Thorn	1 to 4 inches	8 to 16
Ironwood	2 to 4 inches	25 to 30
Choke cherry	1 to 3 inches	12 to 20
Red cherry	1 to 4 inches	15 to 25
Juneberry	1 to 2 inches	10 to 18
Sumac	1 to 2 inches	10 to 16
Hazel bush	1 inch	8 to 12
High bush cranberry	½ to 1 inch	6 to 8
Jack bush		2 to 4
Rose bush		2 to 6
Wild currant, black		2 to 4
Wild gooseberry, white		2 to 5
Wild raspberry, red		2 to 4
Strawberry, vine		
Wild grape, vine		
Wild ivy, vine		
Wild hop, vine		
Bitter sweet, vine		
Wild morning glory, vine		

All of the above varieties are to be found in Sylvatan Park, four miles south of Grand Forks, except a few varieties.

NATIVE TREES OF BARNES COUNTY ON THE CHEYENNE RIVER.

Authority—J. M. Boardman and Hon. John Logan.

Oak, white; oak, red; ash, white; elm, water; box elder, cottonwood, basswood, hackberry, willow, white; willow, water; willow, red; haw, black; plum, red; plum, white; thorn, cherry, choke; juneberry, cranberry, high bush; currants, gooseberries, strawberries.

Mr. Boardman cut an oak a few years ago on his land, Sec. 6, T. 140, R. 58, Valley City, N. D., that had 170 rings, making it, according to writers of good authority, 170 years old.

NATIVE TREES OF RANSOM COUNTY ON CHEYENNE RIVER.

Authority—W. H. White, Esq.

Kind of Tree.	Diameter.	Height in Feet.
Oak, burr	1½ feet	50 feet
Ash, white	1 foot	35 feet
Elm, water	2 feet	50 feet
Box elder		
Willow	4 inches	15 feet
Poplar	½ foot	25 feet
Cottonwood (scarce)	1 foot	60 feet
Basswood (scarce)		
Plum, yellow		
Plum, red		
Thorn		
Ironwood		
Cherry, choke		
Cherry, black		
Juneberry		
Sumac		
Currants, black		
Gooseberries, white		

TREES NOT NATIVES OF NORTH DAKOTA.

The following varieties of trees, as far as can be learned, are not natives of the timber of North Dakota: hickory, black walnut, butternut, beech, rock maple, white pine, hemlock, balsam fir, red cedar and tamarack.

LARGE HARVESTS OF WILD FRUIT, TREE SEEDS AND ACORNS OF NORTH DAKOTA.

The native wild fruit of our State is very voluminous each successive season, although the amount varies from year to year, as in all other states, because of varying conditions. The leading varieties of these fruits consist of plums, June berries, haw, buffalo berries, choke cherries, sand cherries, wild grapes, high bush cranberries, raspberries, currants, gooseberries, strawberries, hazel nuts, filberts and acorns. All these are gathered in large quantities for domestic consumption, and are also sold in the market at remunerative prices. All these fruits are very prolific and of the best quality and thousands of bushels remain unpicked each season. To form an idea of the large amount annually produced I will state it can be demonstrated that the varieties listed below would measure the full amount which I name:

Wild Plums.—This fruit is much better than many domestic plums which I have observed in various states of the Union. They consist of many varieties They are generally large and juicy and afford the most wholesome and agreeable sauce. This fruit is more carefully gathered than any other kind in the State. Much find their way into the market, affording good compensation to the gatherers. The annual crop amounts to carloads.

In 1892, when making collections of forest fruit for the World's Fair, I asked an intelligent farmer, one considerate and reliable, how many plums according to his best judgment, were raised each season on his and his neighbors' farms, consisting of 125 acres of timber land on the Red river, and he answered: "Really, Mr. Barrett, I should say a number of car loads." "But say how many carloads?" "Well, sir, according to my best judgment, to put it safely, I would say, in a good season for the fruit, at least two car loads, and the fruit is always good and nice. One man picked on these lands, in one season 30 bushels and sold them in Grand Forks for $60."

Juneberry.—Very extensive; carloads each year. Berry very large and sweet; makes the best of sauce, pie, etc.

Buffalo or Bull Berry.—Found principally on the Missouri river and its branches, but a few at other points, as at Fort Totten and on the Mouse. It yields a large amount of berries, and they are much used for jellies, etc.

Choke Cherries.—Grow in all woods and along many of the streams and in the valleys of the hills where moisture abounds. Make excellent sauce. Berries of very large size and juicy. The annual crop would fill car loads.

Sand Cherries.—Grow in abundance on low bushes in the Missouri slope. Many used in the family and large quantities put upon the market.

Wild Grapes.—Large amounts gathered annually. A great favorite as it makes superior jelly and sauce. Found in large amounts on the Missouri, its branches at the Turtle mountains, in the Devils lake woods, on the Red river, and elsewhere.

High-Bush Cranberries.—The bushes yield in abundance, and wagon loads could be secured each fall. An excellent berry for home use. Some parties at the Turtle mountains have derived quite a revenue by selling this fruit in the market. One man sold 12 bushels for $24 in one season.

Raspberries.—Are found by the acres, in the Devils lake woods, the Picture Park, and elsewhere—and the yearly crop would fill car loads.

I asked one intelligent gentleman, who was my companion when exploring the Turtle mountains, this question: "How many raspberries are raised in these mountains each year?" and his reply was: "Well, I have known seasons when thousands of bushels have been raised here in our county." (Bottineau.) No better berry for sauce can be found in the union.

Wild Currants.—Excellent quality and large amounts.

Wild Gooseberries.—Yield large amounts. Good quality. It is worthy of mention that our wild gooseberries are plump, juicy, smooth and free from "prickles."

Strawberries.—Found quite extensively throughout the State.

Hazel Nuts.—The hazel nut bushes abound in all sections and yield many wagon loads each autumn.

Filberts.—These nuts are natives of the Turtle mountains and the Red river woods. An excellent nut for eating. Thus far I have found but small amounts in the State.

The hazel nuts and filberts grow on similar bushes. These nuts are gathered extensively and consumed by the families living near the woods.

Acorns.—The amount produced is immense and would furnish cargoes for vessels each returning autumn. The acorns are of much value for fattening hogs. They are equally devoured in the woods by the cattle and sheep. Large quantities are gathered each year and consumed by the children and the adults in the winter months.

The Haw.—Is a good fruit to eat. Quite large amounts grow each year.

THE NATIVE WILD FRUITS SHOULD BE DOMESTICATED.

All the native wild fruit of North Dakota can be domesticated, and under proper tillage would yield a handsome income, besides furnishing wholesome and valuable food for the household.

The aim of this department has been to encourage the domestication of these fruits, and I have rendered considerable assistance to others in procuring varieties, especially the different kinds of wild plums.

NORTH DAKOTA WON MERITED DISTINCTION ON ITS WILD FRUIT EXHIBIT AT THE WORLD'S FAIR.

Indeed, seeing the very great value of our native wild fruit, I took action and secured an extensive collection of the same for a part of the Forestry Exhibit of North Dakota, at the World's Columbian Fair, held in Chicago, Ill., in 1893, whereon, based upon the Sylvatan idea, an award was secured in the form of a diploma and a medal. Thus our State has won a merited distinction and this is more worthy of remembrance for the reason that, according to all the light I can obtain upon the subject, our State was the only state of the union or nation of the globe that secured an award on its native forest seeds, wild fruits, acorns and nuts.

OUR ANNUAL CROP OF TREE SEEDS.

The seeds which our forests yield each season are enormous. The principal varieties are ash, box elder, basswood, cottonwood, hackberry, the poplars and others. These collected, would be sufficient in volume to fill numerous box cars.

The quality of our seeds, nuts and acorns is of the highest order, hardy and sound, and sought for by residents of our own and other states for planting, knowing such seeds are reliable.

LARGE SALES OF SEEDS AND SEEDLINGS.

The nurserymen of our State carry on a large and profitable trade in forest seeds and seedlings. Over 100,000,000 trees have been sold since 1884 by three of the nurserymen of North Dakota, with an additional sale of over 110,000 pounds of forest seed.

WHERE FOREST TREE SEEDS CAN BE FOUND IN NORTH DAKOTA.

At the Pembina and Turtle mountains, Devils lake, Stump lake, on the Mouse, the Missouri, the Red and its many branches, the James, the Cheyenne and on the shores of numerous lakes and streams throughout the State.

WILD FRUITS AND NUTS OF THE TREES, BUSHES AND VINES OF NORTH DAKOTA.

Juneberry, haw, choke cherry, red cherry, black cherry, sand cherry, red plum, yellow plum, high bush cranberry, thorn, bull or buffalo berry, wild rice, red raspberry, black cap raspberry, gooseberry, blackberry, dewberry, strawberry, wild grapes, acorns, hazel nuts, filberts. Total, 20 kinds of wild fruits and many varieties of acorns and nuts.

WHERE WILD FRUIT AND NUTS ARE FOUND.

The following number of kinds of native wild fruit and nuts can be found:

At the Turtle mountains, fruit, 15 varieties, and acorns, hazel nuts and filberts.

In the woods at Devils lake, fruit, 14 varieties, and acorns and hazel nuts.

In the Red river woods, fruit, 14 varieties, and acorns and hazel nuts.

In the Missouri river woods, fruit, 14 varieties, and hazel nuts and acorns.

Very large quantities of acorns are annually produced by the oaks in the Devils lake and Turtle mountain woods, along the Mouse, Pembina, the Cheyenne, the Red river and its branches. And wild hops of the very best quality grow extensively throughout the timbered sections of the State.

THE APPLES OF OUR STATE.

Small fruit, such as raspberries, currants, gooseberries, sand cherries, bullberries, high bush cranberries, wild grapes, as well as the plums and cherries, are being cultivated with highly gratifying results, considering the care and attention, which are but limited, which they receive. And in addition, apples are being raised in many counties, and the results have been such as to awaken the conviction that like Minnesota, (in my pioneer day, as a farmer in that then territory, in climate and soil, Minnesota was considered to be wholly and completely unfitted for the raising of apples, but now it is one of the best apple and fruit growing states in the union) apples can be successfully and profitably raised in our State. In 1882-83-84 apples have been grown in quite large quantities in Pembina, Grand Forks, Traill, Stutsman, Burleigh, Ramsey and other counties. In 1892 I secured some good large varieties of apples of Hon. W. Oscar Ward, which were raised that year on his farm, near Bismarck, N. D., for the World's Fair, where they made a most creditable display.

When our numerous groves of cultivated timber shall have become a little older and thicker, apple trees should do well in the enclosure.

NUMBER OF FRUIT TREES IN NORTH DAKOTA.

According to authentic information furnished this department by the Commissioner of Agriculture and Labor, on Dec. 5, 1891, the number of fruit trees in our State at that time was:

Not in bearing	15,754
In bearing	9,125
Total	24,879

NATIVE EVERGREENS OF NORTH DAKOTA.

Native evergreens are found in our State at the following points, viz.:

White Cedar, or American Arbor Vitæ, in the timber of the Missouri and the declivities of the hills or buttes near its shore;

in the thickets and woods of the Little Missouri; in the ravines and on the foot hills of the Bad Lands and on the Pembina river. The amount, however, is limited.

The *Creeping Cedar*, in the woods of the Little Missouri.

White Pine, along the banks or in the neighborhood of the Little Missouri. Quite large quantities, explorers claim, flourish in that region. A few pines have also been found in the central parts of the Turtle mountains.

Norway Spruce, in the timber bordering on the Little Missouri. The amount of this variety is considerable and in years past they were used by the Northern Pacific Railway company for ties on their line.

The *Creeping Spruce* is also found along the shores and in the vicinity of the Little Missouri.

WHERE THE PRINCIPAL NATIVE TREES MAY BE FOUND.

The following trees are found in nearly all the woods of our State, but abound more extensively as named below:

The Oak.—This tree covers large areas in the Turtle mountains, the Fort Totten Indian reservation, in various sections of Rock Island (Devils lake woods) and along the Mouse river. It also abounds in numerous parts of the woods of the Red river and its branches and the Cheyenne river. The best quality of this tree, according to the observation of the writer, is found on the Red river and its branches.

The Ash.—The ash grows extensively in the Devils lake woods at various parts of the Red river and branches.

The Elm.—This tree is found in numerous quantities in the Devils lake woods, on the Red river and its branches, on the Missouri and on the Mouse rivers.

The Birch abounds exclusively in the Turtle mountains.

The Hackberry is found in quite large quantities in the Devils lake woods and on the Red river and its branches.

The Poplar covers very large tracts of the land of the Turtle mountains, and is found in considerable quantities in the Devils lake woods and on the Red river and its branches.

The Willow flourishes largely along the Red river and its tributaries, the Missouri, Mouse and in the Turtle mountains.

The Cottonwood.—The Missouri river has vast extended forests along its banks and its leading tree is the cottonwood. It is found in large amounts on the Red river and its branches, and it is one of the numerous trees of many in the woods of the State.

The Basswood flourishes in considerable numbers in the forests of the Red river and its branches.

The Balm of Gilead covers many parts of the Turtle mountains.

The Box Elder is scattered in large quantities through all the woods of North Dakota. The largest amounts are found in the Turtle mountains, the Devils lake woods, on the Red and its branches, and along the Mouse, Missouri and the Cheyenne rivers.

The Juneberry and Plum.—These trees flourish in nearly all woods of the commonwealth. They are very pleantiful in the Devils lake and Turtle mountains woods, and they grow in abundance on the Missouri, the Mouse, the Red and branches, and along the Cheyenne river.

NURSERYMEN AND FOREST SEED DEALERS OF NORTH DAKOTA.

In order to assist those who desire to learn the names of the nurserymen and dealers of whom they may obtain needed supplies of trees and seeds, I give a list of all whose names I have learned to date.

E. W. Hasseltine, Grand Forks, Grand Forks county.
C. L. Pratt, Galesburg, Traill county.
J. C. Pinney, Fargo, Cass county.
G. W. Cowtry, Valley City, Barnes county.
L. O. Habestrich, Valley City, Barnes county.
Oscar H. Will, Bismarck, Burleigh county.
James Holland, Bismarck, Burleigh county.
Bergh Bros., Williston, Williams county.

It would be wise for all farmers to secure their stock of parties in North Dakota, where the seeds and trees are acclimated, and generally sound and reliable, but if it is desired to purchase outside of the State, the northern grown stock should be procured, as seeds and trees from southern parts are unadapted to conditions which prevail in our State

VARIETIES OF TREES IN THE UNITED STATES.

Within the area of the United States botanists claim there is to be found about 340 varieties of trees. Of these, nearly every variety of which have been observed by the writer, 50 have been discovered to date in the native woods and forests of North Dakota, and probably more varieties may yet be found.

FORESTRY COMMISSIONERS OF THE DIFFERENT STATES.

The following states have forestry departments and officials who have in charge, as paid servants of the people, this important part of the state service.

New York.—The New York Forestry Commission, having many officials.

California.—The California State Board of Forestry, having many officials.

Colorado.—The Colorado State Forest Commissioner.

North Dakota.—State Superintendent of Irrigation and Forestry.

Maine, New Hampshire, Pennsylvania.—These have active and useful officials.

The governmental forestry officers of Canada are not fully known. The following are names of parties having something to do with Canadian forest lands:

R. W. Phipps, Forest Conservator of Toronto, Ontario.

J. H. Morgan, Amherstberg, Ontario.

A. White, department of crown lands, Toronto, Ontario.

Felix Campeau, Accountant, department of crown lands, Quebec, Quebec.

The following are interested in Canadian forestry associations:

Hon. H. G. Joly, Pointe Platon, Quebec.

Prof. William Saunders, Ottawa.

Hon. William Little, Montreal.

Some of the foreign forestry officials are as follows:

India.—B. Ribbentrop, Inspector General of forests to the government of India, Calcutta.

France.—M. P. Demontzey, Admistrateur des Forests, Nancy.

Switzerland.—E. L. Landalt, Zurich.

Prussia.—K. Donner, Oberlandforstmeister, Berlin ($12,000 per year, with house and pension).

The name and near the size of all the state parks or park woods in the United States:

New York.—Adirondack, proposed, 2,000,000 to 3,000,000 acres; Catskill, proposed, 100,000 acres; Niagara, 30 to 40 acres.

California.—Yosemite.

Massachusetts.—Lynn (city), 1,500 acres.

Foreign national parks:

Dominion National Park, Alberta, Canada, 260 square miles, reserved, 1885.

International parks between the United States and Canada, none.

A NEW WAY TO MANAGE TOP ROOTS.

Extend the roots profusely over a brick pavement, or what is equally as good, a layer of broken stone, and cover with rich soil and then keep moist. The top roots do not appear, but in their place an abundance of laterals. This gives the tree good roots. Try it, it may pay well.

HOW TO TRANSPLANT LARGE TREES.

Select your tree; dig a circular trench around it from three to four feet from the trunk, the ground being solidly frozen; draw it down with a team, retaining the roots imbedded in the soil. At the lawn or roadside plant in the great hole dug the fall before, keeping tree in place by means of long ropes; cover the roots well and mulch. It is a success, being frequently done in our large cities and villages. Some of the most attractive shade trees, beautiful elms six to eight inches in diameter and 35 to 40 feet tall, of Grand Forks, have been planted in this manner.

PROPAGATION FROM CUTTINGS.

During wet seasons, poplars, willows, cottonwoods, etc., can be raised from cuttings. Select well ripened wood—see that the bark is smooth. Cut smooth, using a sharp knife, from eight to 10 inches long, with a diameter of nearly half an inch. Under all circumstances avoid cutting when frozen. When cut in autumn or during warm winter days, bed them in, or pack in damp straw; saw dust will do. Thus let them rest until wanted. Examine them and if, just before planting, they are found shrunk, then immerse in water and soak until plump again. One of the very best times to cut and plant immediately is when the buds begin to swell in the spring. Intrench them on a slant into the soil their entire length, and press the earth close. This should be done in particular at the base of the cutting.

SOIL.—AIROTION.

The soil needs air. We can help it; it will pay us for our labor. Break the soil, harrow and pulverize; break up the saline particles packed in and on the ground, let in the sunshine and the air. Now you have made progress, you make the "dust blanket" just flexible enough to let in the air; the soil now breathes. It becomes healthy and fitted to husband the moisture just below. It involves chemical changes for favorable results. An intelligent farmer says in regard to this air breathing:

"It is essential that the air be admitted within the soil to bring with its coming, oxygen and nitrogen, and take in its going the carbon dioxide liberated in the soil. This coming and going of the air in the soil may be called soil-breathing. The germinating seeds, growing roots and germs of ferment, germs of nitric acid and free nitrogen fixing germs, all breathe the air, all are essential to soil fertility, and to exclude air would surely cause a poverty of crops."

THE PRAIRIE WELL ADAPTED TO THE GROWTH OF TREES.

Experience is proving there is no better soil in any country for tree growth than our prairies here in North Dakota. The soils contain all needful ingredients; strong, light and vigorous, dark colored, attracting seed; productive, conducive to all plant development. With sufficient water, forestal productions, in any desired amounts, is assured to all who will plant and till intelligently. Then work for trees and forests, and bring to view nature's hidden wealth for this and other ages.

WHERE TO FIND MOISTURE.

We cannot yet control the rain; we are as yet in our infancy, though many thousands of years have passed since man made a beginning. When we reach our scientific manhood, who can say the moisture will not come at our bidding? But until the scientific age shall come, we must look below the earth for our moisture, if not found on the surface, or sent to us in form of rain. It is our duty to economize the water contents of soil and earth. This conserved and applied to tree growth, prosperity and comfort are assured.

EVOLUTION OF TREE FORM.

The phenomena of tree form is an interesting study, and leads to the conclusion that a number of causes are operative therein, among which sunlight is an important factor.

In the beautiful, well kept Sylvatan Park on the Red river, owned, it is known, by Joseph Greenwood, I was profoundly impressed with the imposing spreading branches of the great elms reaching out in proper balance in such a way as to fill out the otherwise open spaces just where the sunlight was to be found. This adaptability of these great giant typical elms to their relations and to the other, and the other denizens of the forests, with the seeking, as if by instinct, for the fullest measure of light, suggested the inquiry whether the form of many trees is not due much to the sunlight rather than to any inherent tendency native to the tree.

DIFFICULT TO RAISE TREES ON VIRGIN PRAIRIE.

Trees can be raised on the virgin prairie, but the operation is attended with extreme difficulty. The tough binding grass tends to affect the roots unhealthfully. If circumstances require the planting, then proceed in this way: Dig the hole well, say five or six feet, for trees six or eight feet tall, and at least 18 inches deep. Fill the hole with good nourishing soil, as may be desired, four to six inches. Insert your tree, planting it one inch deeper than when in the woods or nursery; spread out all the roots naturally, cut smooth all broken roots, then if you feel assured the roots are sufficient to support the top, otherwise trim back, and then fill up the hole firmly around the tree; make your mulch six to eight inches deep, extending it out at least one foot beyond the digging; then, if dry, give a good thorough wetting and stop for a while; watch carefully and water again when necessary; be considerate, if the tree droops, it may need air, circulation, as well as water in the ground; work back the mulch and stir up the soil, pulverizing finely. This will help; it is soil cultivation, producing favorable changes, water, and enough for its needs. Some of the mulch may be returned but not all of it. Immediately before winter sets in, give enough water to carry them through the winter drouth. Till and mulch in spring. Thus you may raise some fine trees as a reward for thought and skill.

RASING HEDGES.

Many trees can be utilized for hedges, such as the box elder, the willow, and the buffalo bush. The latter has many points of excellence; good thick hedge, fine shade, attractive foliage and fruit for many uses. An able writer, Prof. W. W. Pendergast, of Minnesota, recommends the buck thorn. This tree flourishes extensively in North Dakota. Prof. P. contends for his favorite thus:

"Soon as the frost is out of the ground in the spring to the depth of three or four inches, mix a pound of buckthorn seed with about two quarts of finely pulverized sandy soil, and having rubbed it well with the hands in a pail of water to separate the three seeds which grew in each pocket, place the mixture in a box six inches square and six inches deep, in the bottom of which several holes have been previously bored for drainage, and cover the whole with half an inch of fine soil. Sink the box in loose soil in some sunny spot, and occasionally sprinkle with soft water slightly warmed. Be careful not to water too frequently or too abundantly, as in such case the seed will rot. If the season is rainy, it will not need watering at all. The ground should be kept somewhat moist, but not wet. About the first of May begin to examine the seed to see if it has sprouted. When the little white roots begin to protrude from the seeds, make a garden bed about a rod square and sow the seeds half an inch deep, making 14 rows, and sowing about 400 seeds to a row. The plants should grow two years in the bed before being set in the hedge-row. Cut back to half their length and set in parallel rows one foot apart, and plant one foot apart in the row, breaking joints so that each shall be opposite the midway point between the nearest two in the other row. Prune severely for the first few years, so as to make the hedge thicken up well at the bottom. A pound of seed should make 180 rods of hedge.

WORK OF INSECTS.

What things are without parasites? They are found everywhere. The forest trees cannot escape their ravage. They come just after the box elders and ashes and other trees are leafing out, millions of crawling impish things devouring their leaves, stems and roots. Paris green often proves successful in destroying the intruders.

But without doubt one of the most useful insecticides destructive to plant parasites is the kerosene emulsion: Dissolve one-half pound of hard soap (best whale soap) in four pints of water by boiling. When the soap is all dissolved, remove from the fire and add eight pints of kerosene and agitate the whole briskly until a permanent mixture is obtained. This is best done by using a force pump and pumping the mixture with force back into the vessel that contains it. The emulsion may be diluted to the desired strength and used at once, or may be used from when needed. The strength ordinarily used is prepared by diluting one part of the emulsion in 10 or 12 parts of water, which makes the kerosene one-twentieth part of the whole.

A MODEL GROVE AND WIND BREAK.

The following plan for planting a grove on a prairie farm has been the most satisfactory of any yet devised. "How can I plant trees to prevent snow from drifting around the farm buildings," has been a common question among the pioneer prairie farmers. This design is intended to answer that question. Of course the plan can be varied to suit the location of buildings, roads and lay of land, but in a general way the main features of the plan should be followed.

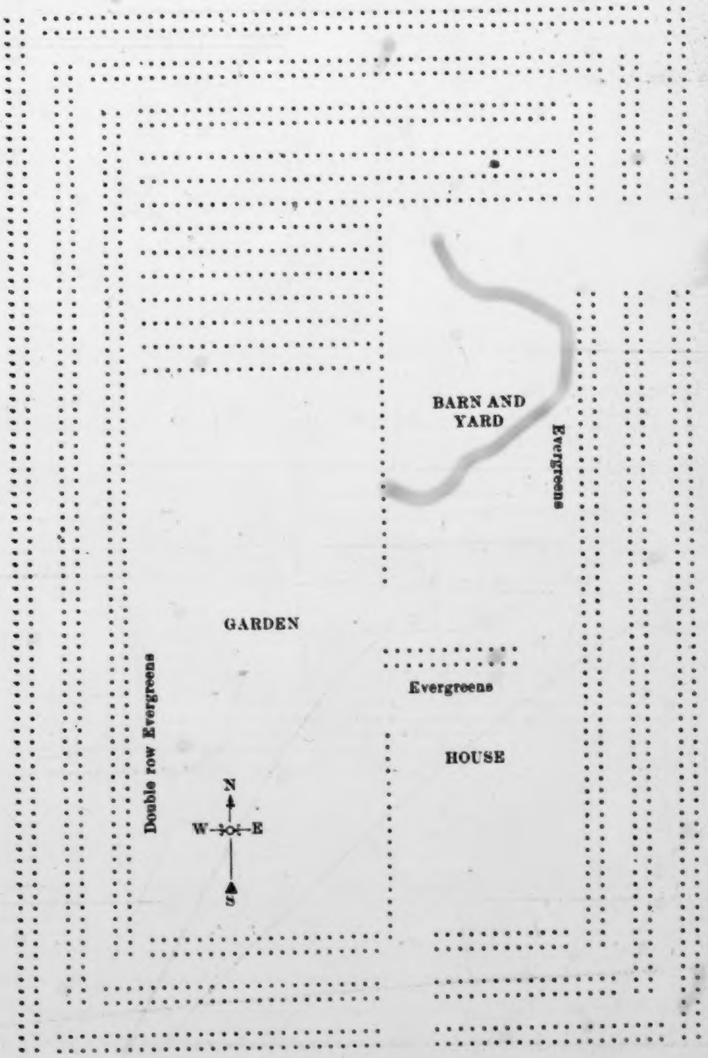
Two rows of white willows around the entire place.

These should be four feet apart and the cuttings should be set only one foot apart in the rows.

Then an open space two rods or more in width to catch the snow, then two more rows of willows like the first, then evergreens eight feet apart in rows eight feet apart, the trees alternating so they break joints instead of coming in regular squares. Trees set in this way break the force of the wind better than a solid row, the object of the solid row around the outside being for the purpose of catching and holding the drifting snow. The main body of trees after the rows of evergreens should be some rapid growing deciduous trees like soft maple, box elder, or white ash. Where convenient the larch or walnut may also be planted. These should be planted four feet apart in rows six or eight feet apart. They should be well cultivated, no weeds or grass being allowed on the ground until the trees are up large enough to shade, so grass or weeds will not grow. Put an extra row of evergreens around the garden and along the west side of the barn-yard; also a double row between the house and barn.

Start a little nursery of evergreens in the garden, at the same time the willows are planted in the outside row, then when the willows are large enough to shelter the young evergreens they are ready to move from the nursery to their permanent place. The "Forest Tree Planter's Manual," published by the Minnesota Forestry Association, Minneapolis, gives detailed instructions how to prepare cuttings, plant seeds, and to transplant and cultivate trees.

C. L. SMITH,
Editor of Minneapolis Weekly Tribune.


BARN AND YARD
Evergreens
GARDEN
Evergreens
HOUSE
Double row Evergreens
N
W
E
S

GRAFTING.

Of late considerable attention has been given to the matter of grafting, and therefore the following comments, taken from the press, may prove of value at this time:

"The kind of grafting most likely to be practiced on the farm is that known as cleft-grafting. The process is a simple one. Saw off the limb to be grafted where it is an inch or less in diameter; trim the edges of the 'stub,' smooth and split with a large knife or a cleaver made for the purpose. The cleft should not be more than four inches deep at the most. A wedge is now inserted in the center of the cleft and a cion is set on each side of the cleft. The cions are made of twigs of last year's growth. They should be cut before the trees show any signs of starting in the spring. When the cion is prepared ready for setting, it should contain about three buds. The lower end is cut wedge-shaped by slicing off each side of the cion. On one side of this wedge-shaped portion, midway between its top and bottom, should be left one of the buds. When the cion is set, this bud will be deep down in the side of the cleft in the stub, and will be covered with wax; but being nearer the source of nourishment, it will be most apt of any buds to grow, and it will readily push through the wax. The cion is set into the cleft by exercising great care that the inner surface of the bark on the cion exactly matches with the inner bark on the stub. A line between the bark and wood may be observed. This line on the cion, in other words, should match the line on the stub. Wax the whole over carefully and thoroughly. Do not leave any crack exposed. Grafting wax is made as follows: Melt together resin, beeswax and tallow in equal parts and spread on cotton cloth. Tear into strips and wrap around graft."

PROTECTING TENDER SEEDLINGS.

Plant young box elders on both sides of the oaks, hard maples, walnuts, basswoods, as they and other choice sorts need protection from hot and cold winds, and when old enough to "go alone" remove the supports.

SCREENS FOR THE TRUNKS.

Use any white but not tarred paper. Wire-screens are a reliable safeguard against the depredation of mice and rabbits, but the most satisfactory disposal of these rascals is their extermination.

ART OF PRUNING.

Avoid everything set or stiffly artificial. Trees should be pruned to healthy conditions, and beauty of form will naturally ensue. Ignorant pruning is one of the unpardonable foes to a tree. Very frequently—indeed the rule of thoughtless intermeddlers with nature's beautiful art of self-preservation—the branches are sawed off an inch or more from the tree-trunk. It is impossible for nature to heal such wounds. Always prune close to the bark. The roots of a tree are proportioned to the branches. If then you saw off large live branches which nature cannot heal over, the roots at once begin to die, and the rotting roots convey rottenness to the trunk. The bungling pruner virtually stabs the tree to the heart, for the stumps he leaves on soon rot, and convey the rotting tendency downward as the rotting roots do upward. A severely pruned, or a badly pruned tree soon becomes hollow, and seldom lasts many years. Prune when the trees are young and "be harmless as a dove."

SEASON FOR PRUNING.

All our foresters and horticulturists agree with J. S. Harris, that from June 25th to July 10th, is emphatically the season for summer pruning fruit and ornamental trees. The secret of good pruning is: Never permit a useless limb to grow. The main part of the work consists in rubbing off the sprouts that will make superfluous branches, and pinching in such as are making excessive growth in the wrong direction, and will tend to throw the tree out of symmetry. If necessary branches less than a half inch in diameter may be removed and the healing process will begin at once, but care must be taken not too remove too much foliage at one time, for it will injure the vitality of the tree.—Forest manual.

MIXING THE TREES.

Rule 1. The main growth, i. e., the one that occupies the larger part of the ground, must be of a kind that improves soil conditions, namely, a densely foliaged, shade-enduring kind, which does not lose its shading capacity with age.

Rule 2. Densely foliaged kinds may be grouped together, if the slow grower will endure the shade of the rapid grower, or can be protected against its supremacy by being planted in larger specimens, or in advance of the former, or in large numbers, or if its gradual killing out after it has served its functions of soil cover is not objected to.

Rule 3. Thinly foliaged kinds should never be grouped together where soil humidity is to be preserved, unless no leafy tree can be found to fit the locality.

Rule 4. In grouping light-needing with shade-enduring kinds, the former must be more rapid growers or must otherwise be given an advantage.

Rule 5. The mixing in of the thinly foliaged trees is preferably done singly and not in groups, unless special soil conditions necessitate the latter method.

With such rules and considerations in mind, the proper practice in prairie planting is indicated.—*Prof. B. E. Fernow.*

PROPORTIONATE AREA OF WOODLAND.

If every 100 out of every 300 acres of land in North Dakota were planted to trees, converting the same into a thick forest, then on the remaining 200 acres a larger and surer average crop of grain and fruit could be raised than is now produced on the 300 well tilled acres.

This proportional amount of forests to the cultivated land is advocated by many of our most conservative foresters. Or to put it in little different form: Let the ratio be, forests one-quarter to one-third of the land, and the best agricultural conditions, all other things being equal, will thus be attained.

Below I give the views of others upon this subject:

Men need to be taught to plant trees, and their children to plant and love them. Owners of good lands in Maine or elsewhere will in the future learn that their bleak fields, if judiciously planted with wood to the extent of 40 per cent. of area, will produce on the remaining 60 per cent. more in all kinds of crops than the whole does now or can be made to do under any other possible course of treatment. Lands well sheltered can and do produce winter wheat in Maine as well as on the new lands at the West. In accordance with this memorial, the State Legislature provided for exemption for twenty years from taxation of all cleared land on which forest trees had been successfully cultivated for three years, and maintained in a thriving condition thereafter.—*Committee on Agriculture.*

What portion of the area of the State should be covered with forests? Economists estimate about twenty-five per cent. as a suitable proportion; but this varies with the position, physical character, and commercial interests of the country under consideration. "I do not pretend that the whole of our farms should be planted in forest trees," says Hon. H. G. Joly, of Quebec; "that would be absurd. Our farms are generally too large for the small number of hands we employ; there are always some odd corners, idle strips, stony or damp patches which it does not pay to cultivate. Begin and plant forest trees there, suiting the tree to the nature of the soil—you will find some for every kind of soil. Once planted and fairly started, they will take care of themselves, give no trouble, and increase yearly in value. If every acre of ground were covered with valuable crops, one would try and get reconciled to the absence of trees, and bow to the iron rule of our age, which converts every thing into cash. But what a small proportion of all that ground is used profitably! We can find plenty of spare room for growing forest trees; they are not only the most beautiful ornaments to a country, and the most useful product of nature, giving fuel, timber, shade, shelter, retaining moisture, and a protection against droughts, etc., etc., but, considering the question from a *strictly money-making* point of view, the culture of forest trees is perhaps the *best and safest investment* that can be made."

NUMERICAL SCALE.

It is the number of trees that yield the best result, not the greatest number that we try to keep growing. What this best number is, depends naturally on the kind of tree; it changes also with age, as the trees need more room, and with soil and situation. In the average we would not be far out of the way to require per tree in the twentieth year 10 square feet, in the fortieth year, 40; in the sixtieth year, 100; in the eightieth year, 125; and in the one hundredth year, 160 square feet growing space, or 4,300, 1,100, 435, 350, and 270, trees per acre, respectively, at the ages noted, would represent about the proper average condition of growth. There are from 50 to 75 per cent. more shade-enduring trees possible on an acre than light-needing; more trees on poorer soils, sometimes two to four times as many than on good soils, and more in the valley, sometimes double that of the higher elevations; so that while a pine growth of, say, 60 years may show 500 trees to the acre, a beech growth may contain 750 trees under the same conditions.—Prof. B. E. Fernow.

TREE CROP.

This is an interesting study, but space cannot be found to present its importance at this time. A studious writer says:

"There is no analogy between a crop of wheat or corn and a forest grove. Trees are not annuals; they belong with the centuries for successive generations. The man who raises them cannot monopolize their benefits if he tries. In a climatic and sanitary sense they are not his alone, though on his own farm. As windbreaks they protect whole neighborhoods, imparting salubrity to all the air we breath. They are educators of patriotic and æsthetic character. Along these lines of use they intrinsically are above all price. Surely the State can afford to improve the general prosperity, healthfulness and beauty of its vast domain."

PARKS FOR THE MASSES.

Public parks are of paramount importance. They have most favorable effects, and shall I name a few? They tend to increase values, give harmony and peace, promote health, conduce to refinement, beautify the abode, the school and "the home of the dead." Then the village, the town, the city and the hills and plains afar and near are adorned by the gathered beauty seen in trunk, limb and waving leaves of the trees sheltering the denizen whose influences they seek. They ennoble character, quicken thought and awaken the æsthetic, the pure and the divine things of mind and soul. They are the adjuncts and evidences of intelligence, culture, progress, and the higher civilization of the children of Perfect Grace. Then should not a park be made commodious and attractive? If this is done they will sanctify and bless the young, the feeble and the old, and prove a source of pleasure to the strong and active.

The creation of parks constitutes one of the leading objects of the Sylvatans and they are of such value that the press, the church, the school and the statesmen should help in their establishment in all sections of our young and vigorous State.

A thoughtful writer says:

"Much attention is paid to parks in our cities, and most of our villages follow suit. Nothing contributes more to the health and contentment of the masses than these rural retreats. But why limit park improvement and its educative influences to the populous centers? The monotony of country life that tends to drive the young folks into the surfeiting cities can be largely neutralized by legislative encouragement to the development of public parks in the country places. One of the very best ways to enrich the State is to transform the waste lands in every county and township into free forests for the people's rest and recreation, serving also as public wind-breaks and water reservoirs."

THE PARKS OF NORTH DAKOTA.

Our State contains numerous retreats, groves and noted parks. Though but in the infancy of our statehood, these places of recreation and instruction have become endeared to the people. I will name a few:

The Picture Park, being the National Turtle Mountain Timber Reserve, containing 183,000 acres. Here, overlooking the far-extended plains, are a succession of mounts and hills, clothed with the enchanting forests, with gurgling springs and streams meandering the broken wildwood through.

The Sylvatan Park, located on the Red river, four miles north of Grand Forks. It contains 75 acres of forests, where nature has bestowed most bewildering beauty and fascinating charms.

The Capitol Park at Bismarck.
The Central Park at Fargo.
The World's Fair Appel Park at Bismarck.
Freldom's Park, of Ramsey county.
Ridgeview Park, of Ramsey county.
The Sylvatan Park, of Coulee, Ramsey county.
The Emvo Grove of the same place.
The Forest Home in the Devils Lake woods, Benson county.
The State Militia Park at Devils lake.

The Chautauqua Park at Devils lake.
The Kildahl Park of Irvine, Ramsey county.

THE NORTH DAKOTA STATE MILITIA PARK.

Through the efforts made by our delegation in congress, in respect to a concurrent resolution passed by our legislative assembly, land has been secured for a State Militia Park. It constitutes the southern portion of Rock island, which projects out into the deep waters of Devils lake. It was formerly a part of the Fort Totten reservation, and is bounded as follows:

"That portion of the tract known as Rock island, bounded on the north by an east and west line two miles back on the north of the southeast point of said island or peninsula; said tract being the southernmost point on the north side of Devils lake in North Dakota," for the use of that State as a park for the use of the State militia, and for other purposes not inconsistent with such use. It is provided that if the State remits the use of this tract for any purpose not contemplated in this bill the lands shall revert back to the United States.

Gratification is afforded to our citizens in the remembrance that it is a wooded tract, the prevailing trees being the oak, but a few ash and box elder and other trees, together with wild fruit trees and bushes, abound. The oaks are of good size, reaching high. These stand together quite closely, affording cool and attractive shade to the visitors who in summer time seek these "sylvan wilds." Along the edges bordering on the lake large bowlders appear, huge monsters of granite sleeping in sand beds piled by the waters and winds near the border of the forests. Southward roll the waves of "Dakota's inland sea," the historic Devils lake, that charms the eye and fascinates the mind. Its northern limit borders upon the Chautauqua grounds. Travelers reach it in less than an hour's ride from Devils Lake city, the nearest railroad station, and it is one of the most charming spots in the West.

Relying upon its importance, it is expected our next legislative assembly will make provisions for its care, protection and improvement, with suitable buildings for the soldiery.

North Dakota is certainly fortunate in having a forest park for the soldiers of loyal devotion, ever ready to uphold the integrity of the State and its laws, and to protect the people from all dangers that may beset them.

It requires but little discernment to perceive that in the near future the "State Militia park of North Dakota," located near the hum and tread of a busy population, will become a favorite retreat of all who love "the forests wild," green in their beauty, on upland and plains, rolling afar from the flashing tide.

CITY AND VILLAGE SHADE TREES.

Shade trees are found in nearly every village and city in

North Dakota. These evidences of refinement, culture and the desire for the most favorable environments are found in Devils Lake, Grand Forks, Fargo, Wahpeton, Grafton, Lisbon, Valley City, Jamestown, Bismarck, Mandan, Dickinson, Minot and many other of the large places of the commonwealth.

FORESTS PLANTED BY THE BIRDS.

The benefactions of our birds are by no means circumscribed to protection of our crops by their devouring preying insects, nor to the food they supply us with. In his "Origin of Species," Charles Darwin shows how certain birds annually cross the Atlantic, bearing forest and other seeds adhering to their claws and beaks, depositing them on the islands and continents, some of which will spring up and live. It is not too much credit to say the birds and squirrels have planted the forests of the world, and by right they are theirs to live in. With a view to save them for food, no doubt, like the dog that buries his bone of meat, crows have been known to dig holes in the ground with their beaks and there deposit acorns, which sprout and grow into great oaks. No birds, perhaps, have done more to carry seeds from one part of the world to another, taking root where they can, than the wild geese, which are fast learning to leave us for other regions to escape from utter extinction.—*Progressive Age.*

OUR INSECTIVOROUS BIRDS.

Frank H. Palmer, in "Agriculture of Massachusetts," aptly says: "If left to herself, nature establishes a wholesome equilibrium between the feathered and insect tribes. She produces no more insects than can be kept in check by the birds. But man, by his artificial habits, disturbs the proper balance between these tribes. By cutting down the woods, by disturbing the quiet of the forest by the sharp report of the gun, he destroys or drives away the birds, and thereby stimulates the production of insects, which become almost the greatest pests of the agricultural interests of the country. Nature has given to birds an appetite and an instinct which teaches them exactly when and how to go to work to capture and destroy insects and their eggs; and if the number of eggs produced by insects is wonderful, so the number destroyed by a single bird is marvelous. Bradley says that a pair of sparrows will destroy 3,300 caterpillars in a single week. Another reliable ornithologist states that two old birds with five young will destroy in a single day's feeding 700 insects.

IMMENSE CONSUMPTION OF TIMBER IN THE WEST.

Not only are the forests vanishing from the hills and the low lands of the East and South, but in the great Northwest the necessity for lumber has become so great that unless there can be a larger amount of replacement in way of domestic trees, and a more economic care of the young native growth, the drouth and desolation now upon the land will increase in double ratio. In order to impress the mind with the dangers that beset us I present the following statistics of the cut of but one specie of trees—the white pine—in the Northwest in the year of 1892:

On Mississippi, above Minneapolis	109,863,378
At Minneapolis	488,724,624
On main river between Minneapolis and St. Louis	931,806,305
On St. Croix river	175,891,427
On Black river	240,678,500
In Chippewa valley	298,833,782
In Duluth district	349,394,000
St. Paul & Duluth railway	75,955,000
Ashland district	273,229,877
St. Paul & Omaha railway	286,311,383
Wisconsin Central railway	301,806,875
In Wisconsin valley	456,153,872
Sault Ste. Marie railway	293,565,541
In Red River valley (estimated)	100,000,000
Taken to Canada (N. W.)	150,000,000
Total number of cubic feet	4,530,315,565

CRIMINAL IMPROVIDENCE.

No true forester protests against the legitimate demand and use of lumber, but he rather points out the amount of consumption in order to prove the absolute importance of greater care of the forests, their proper cultivation and protection from fires, browsing animals and all destructive agencies, and the extension of new forests on treeless lands. And as a trustee of nature's inheritance, the intelligent forester declares against the criminal improvidence of our age. Carl Schurz, the orator, viewing this matter in the true light, is credited with saying:

"To bring up the public opinion of this country to the point where it will command such measures, a vigorous and unceasing agitation is required. I do not underestimate the difficulties it will have to overcome. It is the shortsighted greed which acts upon the rule to grab all that can be got at the moment, and 'let the devil take the hindmost,' not stopping to consider that he who does so may be among the hindmost himself, and that in this case his children certainly will be. It is that spirit of levity, so prevalent among our people, which teaches to eat and drink and be merry today, unmindful of the reckoning that will come tomorrow. It is the cowardice of the small politician, who, instead of studying the best interests of the people, tremble lest doing his full duty may cost him a vote, and who is not seldom apt to fear the resentment of the theives more than that of honest men."

THE FORESTS SHOULD BE PROTECTED.

It is a matter of the highest importance that the forests should be protected, not from proper use and consumption, but from reckless and criminal waste. They were planted around the head waters of the greatest river in the country to serve an important purpose in the economy of nature. It is possible to make use of them and at the same time preserve them and perpetuate their usefulness. But it is not possible to escape the direct consequences if the provisions of nature are so far disregarded as to permit the work of destruction to go on at the rate now practiced. There is not a farmer, or railroad man, or merchant, or any other kind of business man in this State who is not vitally interested in this matter. The farmer needs the forest. How much he needs it will be apparent to him in a very few years at the present rate, if it is not clear now. The day of reckoning is not far off.—*Farm, Stack and Home.*

HAVE WE OF NORTH DAKOTA NO RIGHT IN THE FORESTS OF ADJOINING STATES?

Man by his organization and necessities is dependent upon the elements of nature, and in them he has certain inalienable rights. He is entitled to the sunlight, the air, access to and the cultivation of the earth, and he cannot exist without heat. And he must have the forests from whence to draw his supply for fuel, for buildings, machinery, etc. And Providence, through the beneficent gifts of nature, has furnished these things free to man, at least most of them. Hence by the law of justice and natural right has not North Dakota, and the other prairie states, a right to be heard pleading for a more economical use of the timber of Minnesota, Wisconsin and Michigan, from whence such treeless states derive their supply? Yea, is it not the duty of these dependent states to insist that measures should be instituted by the legislators of those timbered sections, having in view the protection of the forests therein from the fires, and waste, and illegitimate destruction of the timber? We give our surface water, in form of evaporation, for the furnishing of those very forests with rainfall, which they attract or entice away from our treeless lands. We also furnish, probably, a certain amount of underground waters for parts of those territories. And out health-laden winds sweep across the intervening space, to bless the people in those lands of forests. Then should not there be a reciprocity, and the timbers receive better protection for the good of the timbered and untimbered states of the West?

MARVELOUS CONSUMPTION OF THE TIMBER OF THE NATION.

We consume in the United States 25,000,000 acres of forests each succeeding year by the axe alone. Thus we cousume our timbers twice as fast as they grow, not counting the immense loss by fires. The next quarter of a century is expected, by the intelligent investigators, to exhaust the white pine supply of Minnesota.

As the forests are destroyed, the rainfalls decrease. Then follows, what? Drouths and losses; the remaining timbers dry up, inviting more fires, and their destruction is multiplied enormously. Then, is there not need of a conservative and intelligent administration of forestry in all states of the Union, and a national forestry department, that the timbers on the public domain may be rescued from annihilation, in time to prevent the direful calamities that must befall us by the utter deforestration of the nation.

ANNUAL CONSUMPTION OF TIMBER.

The annual consumption of timber in the United States for some of the great industries, is as follows:

	Cubic Feet.
Lumber	2,500,000,000
Railroads	500,000,000
Charcoal	250,000,000
Fencing	500,000,000
Fuel	17,500,000,000
Mining	150,000,000
Total	21,400,000,000

DECREASE IN TREES—DECREASE IN WATER SUPPLY.

In every nation and in every clime we find this same fact plain and indisputable. Wherever trees are destroyed in large quantities there is a decrease in the supply of water, for the protection removed, the snows are exposed to the direct heat of the sun at springtime, and hence soon melt and run off to the seas; and the winds and heats of summer, operating in direct contact with the surface water, causes great and rapid evaporation, and thus and for similiar causes, there becomes a scarcity of water, inviting drouths, decrease of productions, impoverishment and want. It is well to learn these facts, that the deforestration of the land may be abated, and reforestration encouraged in every desirable way.

The facts cited above are well illustrated in the case of Greece. In ancient days she possessed 7,500,000 acres of forest. Today she has hardly 2,000,000 acres; and the scarcity of water and other injurious climatic effects, are traceable to the destruction of the trees.

LET ALL CONSIDER THE EFFECTS OF DEFORESTRATION.

Bucharia had a sad history owing to the destruction of its forests. Less than 70 years ago this county was "one delicious garden—on every side villages, rich cornfields, fruitful orchards, country houses, gardens, meadows—interspersed by rivulets, reservoirs, canals—a living picture of industry and happiness." For some reasons, near 40 years ago, the inhabitants began to cut down the trees, and during the civil war what was left was consumed by fire. Then, as a natural result, the waters dried up, the land turned into sandy deserts, and desolation and solitude prevailed.

Like results have followed deforestration in certain parts of Turkey, India, Egypt, Greece, Italy, Spain and the once prolific and hardest laden Euphrates. And the same is true of Palestine. The land of the Nazarene, once flowing with milk and honey, is now a barren and unproductive land, because the forests have disappeared. And so this barrenness and drouth prevails throughout the world where man in his cupidity and blindness ignores the necessity of a proper balancing of meteorological forces of nature.

But we need not go abroad for lessons. The hardy yeomanry of New England, Pennsylvania and other middle states have leveled the forests and cleared the land, and now the harvesting has come—arid hills, wornout valleys; waste and deserts; toil and impoverishment resulting from the destruction of the forests in those once favored regions.

But it is a hopeful sign of a new order of things along the line of economic reforms, when these facts come home to the thinkers and they declare the truth and give a warning voice to the people. Thus speaks the writer, J. B. Harrison:

"We have wasted and are still wasting our resources in fish and game, in forests and water sources, in the fertility of the soil and in other storehouses of the nation's natural wealth, as if responsibility to the future for our action as trustees of this magnificent inheritance had for us no existence."

Geo. P. Marsh declares: "The earth is fast becoming an unfit home for its noblest inhabitant, and another era of equal human crime and human improvidence, and of like duration with that through which traces of that crime and that improvidence extend, would reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the deprivation, barbarism, and perhaps, even the extinction of the species."

And Charles Darwin, nature's grand student and expounder of her balming forces, tells us: "So profound is our ignorance and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world, or invent laws on the duration of the forms of life."

DESTRUCTION OF TIMBER IN CANADA.

One hundred years ago Ontario was a forest country, and now it has only from 10 to 20 per cent. of timber, with millions of acres of barren waste lands, and no increase to replace this waste of timber. In 1883 the Province of Ontario distributed 15,000 copies of their forestry report, giving directions and instructions calculated to encourage and stimulate the planting of forest trees.

To have a forest area in our country outside of Alaska in proportion to that of Germany, our government should have under its control 700,000,000 acres in reserve for timber, and otherwise, utilized as parks.

NEBRASKA FORESTRY.

Data, as near accurate as may be, show that the acreage in Nebraska since the extinguishment of the Indian title to lands, and the passage of the Kansas-Nebraska act, in 1854, is, in round numbers, about 2,021,543 acres. We have planted about 6,065,689,750 trees. We reckon 3,000 trees to the acre, four feet by four. It is safe to say that the spontaneous tree growth in the territory and state since fires have not been permitted to run over the prairies, has increased over the original timber area quite one-half as much as has been planted. Thus the total increased timber area or acreage for the 40 years has been, say 3,032,319 acres.—*Ex-Gov. Furnas.*

THE LESSON SHOULD TEACH AMERICA.

Perhaps it is ordered that the race shall destroy forests forever, and never restore forests. The Holy Land, all the desolate Orient, once glorious in forests, luscious in fruits and fragrant in flowers, recites man's improvident and wicked waste of trees. The lesson should teach America. It, when translated to the understanding, is only a picture of our future if we also destroy, seldom conserve, and never plant great forests. What came to the axemen of the Orient will come to those of the Occident. The same causes give inexorably the same results. * * * It may be that the life of a race of men is limited by the duration of the forest or woodland area which they encounter at the beginning of their career.—*J. Sterling Morton. Secretary Department of Agriculture and Originator of Arbor Day.*

A BILL FOR THE PROTECTION OF THE NATIONAL FORESTS.

The bill below (H. B. 119) has long been before congress. It has been fully endorsed by the committee to whom it was referred. Its merits commend itself to every forester and statesman of the Union. No one can deny the necessity of such a measure in the form of a law. If it becomes a law, it will give the Secretary of the Interior the right, duty and power to protect all national timber lands.

This bill has now passed the National House of Representatives, and will ere long come before the Senate, and the prospects are good for its passage by that body.

This bill has received much attention from the writer. My letters to the members of Congress from our State, called forth such replies as to indicate each—one and all—earnestly commend the bill, and doubtless it will receive their unqualified support.

The bill was introduced September 6, 1893, by Hon. Thomas C. McRea, chairman of the committee on public lands in the House of Representatives. The measure is entitled, "A Bill to Protect Public Forest Reservations," and is divided into eight brief sections, as follows:

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That all public lands heretofore set apart and reserved by the President of the United States, under the provisions of the act, approved March third, eighteen hundred and ninety-one, or that may hereafter be set aside and reserved as public forest reservations, shall be, as far as practicable, controlled and administered in accordance with the provisions of this act.

SEC. 2. That no public forest reservation shall be established except to improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of waterflow and continuous supply of timber for the people.

SEC. 3. That the Secretary of the Interior shall make provisions for the protection against fire and depredations of the public forest reservations set aside, or that may be set aside, under the said act of March third, eighteen hundred and ninety-one, and he may make such rules and regulations and establish such service as will insure the objects of such reservation, namely, to regulate their occupancy, to utilize the timber of commercial value, and to preserve the forest cover from destruction: Provided, that no timber of commercial value shall be sold except to the highest bidder, on sealed proposals after due appraisement, as hereinafter provided, at not less than the appraised value thereof.

SEC. 4. That before any sale of timber of commercial value on any forest reservation shall be made, notice thereof shall be given for at least thirty days, in a newspaper of general circulation, printed and published at the capital of the state or territory, and shall also be published, when practicable, in a newspaper printed and published in the county and counties in which such reservation is situated, describing by number the tracts of land on which the same is situated and the location thereof, and designating the land office of the district in which the land is situated, as the place where such sealed proposals will be received, and stating the time within which such sealed proposals will be received. All such sales will be for cash, payable at the time of sale at the land office of the district in which such land is situated, and the proceeds shall be accounted for by the receiver of such land office in a separate account, and shall be conveyed into the treasury as a special fund, to be expended in the care and management of such reservations in such manner as Congress may provide.

SEC. 5. That the Secretary of War is hereby authorized to make such detail of troops, for the purpose of protecting said reservations, as the Secretary of the Interior may require.

SEC. 6. That any public lands embraced within the limits of the forest reserve, which, after due examination, shall be found better adapted to agricultural than forest uses, may be restored to the public domain upon the recommendation of the Secretary of the Interior, with the approval of the President, after sixty days' public notice in two newspapers of general circulation in the state or territory where the reservation is situated.

SEC. 7. That any timber on the public lands, not within a forest reservation, may be sold by order of the Secretary of the Interior, in the same manner as is heretofore provided in this act: Provided, That it shall be first shown that such cutting will not be injurious to the public interests: And provided further, That no timber on the public lands shall be disposed of, except in accordance with the provisions of this act.

SEC. 8. That all acts, and parts of acts, inconsistent with the provisions of this act, are hereby repealed.

It might be added that Secretary of the Interior Hon. Hoke Smith approves of the bill, and Hon. W. M. Stone, Commissioner of Public Lands, has recommended its passage. The original bill did not contain all the above, but several amendments have been inserted, which make it satisfactory to the officials named.

FORESTRY IN FOREIGN COUNTRIES.

France, Austria, Russia, Switzerland and Prussia, of European countries, are perhaps making greater advances in forestry and tree planting than all other parts of the world. In these, as well as some of the smaller kingdoms, the government either owns or controls all of the timbered lands.

In Prussia there are 20,000,000 acres of forests; and of this, one-half is owned by the government. This brings in an annual income of $14,000,000 at an expense of $7,500,000, leaving a net income of $6,500,000.

Saxony, from her 4,000,000 of forest lands receives an annual net income of $1,125,000. Bavaria, from her 3,000,000 acres receceives annually a net profit of $4,500,000.

They plant annually 30,000 acres, requiring 35,000,000 plants and 1,000,000 pounds of seeds.

In Austria, much of their domain has been sold of late years, but they now have nearly or quite 2,000,000 acres, which yield a net profit of 25 cents per acre.

In France, the government owns 7,500,000 acres of forests, while 15,000,000 acres are owned by the farmers and private corporations; but in one sense it may be said to be all under government control, for by a well regulated system of protecting and preserving, adopted by the government a number of years ago by purchase and by enactments, these vast forests are now not only a source of wealth for their commercial value, but by this system barren fields are becoming fertile, and thousands of acres, which by their conformation were being washed away, are now protected and saved.

The French government has, at great expense, replanted vast and almost barren districts. and has established great forests along the sea shore where formerly the sand threatened to destroy large areas, and by this judicious method they have averted the evil, and this barren waste will in a few years be a source of revenue as well as benefiting in a climatic point.

In ancient times Greece possessed something like 7,500,000 acres of dense forest, and she was comparatively rich in timber until half a century ago. Many forests have now disappeared, and the result is seen both in the scarcity of the water supply and in various injurious climatic effects.

Germany has an annual income of $57,000,000 from her area of 33,000,000 acres of timber.

Australia is about the size of Illinois and Iowa combined, yet maintains 32,000 forestry officers, and receives a large net income from this source.

ROADSIDE TREES IN FRANCE.

The planting of trees along the public roads of France is considered worthy of statistical mention. At present the total length of public roads in France is 18,750 miles, of which 7,250 are bordered with trees, while 4,500 miles are already being planted, or will shortly be planted. On the remaining 7,000 miles the nature of the soil does not admit of plantations. The number of trees already planted amounts to 2,678,603, consisting principally of elm, poplar, acacia, plane, ash, sycamore and lime trees.

PERCENTAGE OF GOVERNMENTAL OWNERSHIP.

In Germany two-thirds of the forest area is maintained by the government. In Austria 13 per cent. of the forest area is in the hands of the government. Switzerland has only four per cent. of its forest under complete governmental control, but governmental control is exercised over 66 per cent. of her forest area. Italy owns but 1.6 per cent. of her forest area. A law was enacted in Italy in 1888 requiring reforestration of all desert mountain lands. In France the government prevents the cutting of timber even on private lands when that cutting is detrimental to the public welfare. Ten per cent. of the French forests are held by the government. Spain owns 4½ per cent. of her forests, but controls 80 per cent. of her forest area. Fifteen to 20 per cent. of the Scandinavian forests are owned by the government. Russia owns two-thirds of her forest area. England has just begun the work of planting trees in waste places. India's forest revenue amounts to several million dollars annually, but Germany leads the world in forest management.

PLANTS OR TREES PER ACRE.

The following table will be found very convenient, as giving the number of plants or trees on an acre, at various distances apart:

6 inches apart each way	154,240
1 foot apart each way	43,560
1½ feet apart each way	19,360
2 feet by 1 foot	21,780
2 feet apart each way	10,890
3 feet by 2 feet	7,260
3 feet apart each way	4,840
4 feet apart each way	2,730
5 feet apart each way	1,750
6 feet apart each way	1,200
8 feet apart each way	690
10 feet apart each way	430
12 feet apart each way	300
15 feet apart each way	200
18 feet apart each way	135
20 feet apart each way	110
22 feet apart each way	90
30 feet apart each way	50

Rows six feet apart, and trees one foot apart in the row, 7,315 trees per acre.

Rows eight feet apart, and one foot apart in the row, 5,434 trees per acre.

Rows 10 feet apart, and one foot apart in the row, 4,389 per acre.

One mile of windbreaks or shelter belt requires 5,280 trees or cuttings for a single row, one foot apart in the row.

NUMBER OF SEEDS TO A POUND.

By reliable nurserymen it is computed the number of seeds per pound is as follows:

Box elder	5,000 to 6,500
Ash	7,000 to 9,000

VALUE OF THE DIFFERENT SPECIES OF WOOD AS FUEL.

The following table is useful as showing the relative value of various kinds of wood for fuel, taking shell back hickory as the standard, at 100:

Shell bark hickory	100
Pig nut hickory	95
White ash	77
White beech	65
Black birch	63
White birch	48
Butternut	51
Red cedar	56
Wild cherry	55
White elm	58
Hard maple	60
Soft maple	54
White oak	81
Black oak	71
Red oak	69
White pine	42
Yellow poplar	52
Lombardy poplar	40
Black walnut	65

FOREST SEEDS.

All forest seeds may be safely gathered a little before they are ripe. Among the earliest seed to ripen in the fall is the box elder (*Negunda froxin foliam*). The ash (*Fraxinus*) matures just after the box elder; and so do the sugar maple (*Acer saccharinum*). As soon as gathered, spread them out thin on a floor under cover, and stir them with a rake once a day, at least, until well dried, and keep in bags hung up in a cool place—if dry, a cellar. Mixing in some sand will help secure regular and even temperature during the entire winter.

November is a favorable time for fall planting, before the cold freezes up the ground. As a rule spring planting is considered safer, as then the earlier frosts may be avoided. In this case you should soak your seeds in water until well swelled out, or nearly ready to sprout, but the soaking must be made in running water, or the water, not too cold, should be changed every day. The ash is found to be more refractory and should be kept in clean, fresh water, changed daily, at least three or four weeks. The spring planting should be done in moist soil. Do not expose the wet seeds to wind or sun. Plow deep and pulverize well, as for corn. If not a better method at hand, you can remove all the teeth from your cultivator except the two last towards the handle; spread arms apart from two to two and a half feet, and running straight as possible, make two drills at a time. Sow the seeds comparatively thin and cover with a harrow running straight and lengthwise with the drills. If but a few trees are wanted, sow in a bed closer in the rows. The smaller the seed, less the covering, larger the seed, deeper the cover. Birches and alders have little winged seeds grown in catkins. Better sow them, when ripe, near the first of October, in beds, or soon as gathered. They can, however, be kept over winter, for spring planting, by drying and covering them from the air, in a dry, cool place. Cover very thin in planting; half an inch even is too much, and will prevent germination.

The seed of the beautiful hackberry (*Celtis Occidentalis*), native in our woods, and susceptible of culture, is about the size of a pea. Wash the sweet pulp and the seeds and mix with sand for early spring planting; keep in a dry, cool place.

Linden or basswood (*Filia Americana*) bears a round, gray colored, hard seed, which ripens after the frost in autumn. Gather and sow at once. The seeds do not always come up the first spring, but may do so the next.

Acorns and nuts should be gathered shortly after falling from the trees, for they are liable to germinate soon after falling on damp ground. Mix them with coarse or fine sand that has been thoroughly dried in the sun, and keep under cover in a cool, dry place until late in the fall. Plant where you desire them to permanently stand; or, if you choose, put them in drills for transplanting.

Walnuts (*Juglans Nigra*), butternuts, (*Juglans Cincrea*) and hickories (*Carya*) need similar care. These oily nuts are liable to become rancid under a warm temperature, and then their vitality is destroyed. See that they are kept in cool shade, and plant as you do the acorns of the oaks (*Quercus*), late in the autumn. Cover these nut seeds about two inches.

Have you an intention to plant fir, spruce or pine seeds? Then gather such just before the scales of the cones begin to gape or open and shed their winged and naked seeds. Some of the cones, it will be found, will need the application of artificial heat before the scales will open. When the seeds drop out, put them in small boxes, well covered, under an even, moderate temperature, well protected from humidity and the heat of the sun.

Remember and get all your seeds from the trees of North Dakota, native or cultivated; they are acclimated. But if you must go out of the State, buy northern grown seeds, and take nothing but the very best; they are much the cheapest in the end, and far more profitable.

GENERAL DIRECTIONS FOR PLANTING.

Your soil must be all ready before you can unbury a single tree, and all your tools in proper order. Do not venture to plant while the ground is so wet as to make a mortar, or the water collects in the hole. If you do the soil in contact with the roots tends to become hard in drying, to the great injury of the growth. The following are laid down as safe rules:

Be careful not to expose the roots of trees to the wind and sun. More failures in tree planting arise from carelessness in this particular than from any other cause.

To prevent this, carry the trees to the field to be planted in bundles covered with mats; lay them down and cover the roots with wet loam, and only remove them from the bundle as they are actually required for planting.

Before the tree is placed in the ground, examine it closely and trim it in such a manner that there will not be too much head for the roots to support; cut back liberally, but properly. Cut all limbs off close to the bark, so the wounds may heal over nicely. Leave all roots possible; trim up with a sharp knife every broken or bruised root. Now ready, plant.

In planting, the roots should be carefully spread out and the soil worked among them.

When the roots are covered, press the earth firmly about the plant with the foot.

Insert the plant some deeper than it stood before being transplanted.

Select, if possible, for tree planting a cloudy or rainy day. It is better to plant after the middle of the day than before it.

All young plantations must be protected from cattle and other browsing animals—the greatest enemies, next to man, to young trees and the spread of forest growth.

Tree planted, mulch well and liberally.

If soil is too dry, dash on good quantity of water and quit. Water only occasionally and then plentifully.

Now take care of the trees and reap your reward, for nature is bountiful, if you heed her teachings.

COPYING NATURE'S METHOD.

Experiments have been tried, and with considerable success, to raise forest trees by sowing broadcast the seeds of the box elder, ash, oak, birch, sugar maple, hackberry, etc., as is done in some parts of Europe where conditions warrant. This method has promise where the soil is moist. The crop the year of the seeding must be a clean one, say of corn or potatoes, and all the weeds and grass absolutely subdued. The plowing must be deep; well to use a subsoil plough, and harrow the land till as mellow as an ash heap. Then mix the seeds together promiscuously and sow broadcast, putting on a liberal quantity. Next spring they will come up thick, but will thin themselves out on the principle of the "fittest." The growth will be comparatively slow, but healthful if the weeds are hoed down during the growing season. In due time you will have one of the best and most beautiful forests on the open prairie. This is the cheapest way by far. Try it.—*Forest Manual.*

CLOSE PLANTING.

Yes, the above is a good way to raise a forest; at least in

North Dakota it would be found to possess much merit. But if any one desires to raise trees through the seasons of drouth and hot winds, then plant close in rows, three to four feet apart. Sow as you would garden seeds, then cultivate and keep down the weeds. The young trees furnish sufficient shade to protect each other, and thus withstand the bad effects of the hot sun. I have tried this system, and so has a neighbor, and we have both met with the very best success. Our trees are now compact groves, fine wind breaks, healthy, 12 to 15 feet tall, and bearing seeds at the end of six years. These are the box elder trees. The plan is worthy of the experiment.

BEST TREES FOR PLANTING IN NORTH DAKOTA.

I present the trees in the order of their importance, as I understand their merits:

Cottonwood, box elder, poplar, willow, ash, elm, birch, oak, basswood, hackberry, and balm of Gilead.

Fruit Trees.—Plum, juneberry, cherry, buffalo berry, high bush cranberry, and haw.

Evergreens.—White pine, Norway spruce, white spruce, Scotch pine, red cedar, and arbor vitæ.

THE USE OF FORESTS.

They are the source of wealth.

They supply fuel and material for building and mechanical and commercial use.

They give a home-like character and pleasing effect to prairie and hill.

They shield from the fury of wind and storm.

They mitigate the chill and cold of winter and decrease the heat of summer.

They diminish the destructive effects of freshets and conserve the water for future use.

They increase the action of springs and assist in maintaining the flow of brooks and streams.

They tend to a more even distribution of precipitation throughout the year.

They aid in the decrease of hail storms and materially modify the severity of the weather, and improve sanitary and climate conditions.

They protect the home and school, man and beast.

They add to the beauty and the attractiveness of the abode and the landscape.

They afford cool retreats of shade and green for the old, feeble, young and all, and in many lands they furnish fruit and food for human needs.

They promote æsthetic taste, exalt the ideal art of mind, dis-till sweet, pure influences and awaken the highest poetic nature of the soul.

They continually give forth moisture to the air, and hence they, as well as water, are important factors in cooling the hot winds and in preventing droughts.

They ever point upward to the Great Creator, and silently teach all men to look above for blessings.

STATE OF NORTH DAKOTA.

Executive Department.

Arbor Day Proclamation.

"What does he plant who plants a tree?
He plants in sap and leaf and wood,
In love of home and loyalty,
And far-cast thought of civic good—
His blessings of the neighborhood,
Who in the hollow of his hand
Holds all the growth of all our land—
A Nation's growth from sea to sea
Stirs in his heart who plants a tree.

IN SYMPATHETIC accord with the wishes and pursuant to an established custom of the people of our State, I, E. C. D. SHORTRIDGE, Governor of the State of North Dakota, do hereby designate and proclaim

Saturday, the Sixth Day of May, 1893,

——AS——

ARBOR DAY

And earnestly recommend a universal and appropriate observance of the day by the people of our State, and especially by teachers and pupils of our public schools. Let each person, young and old, feel it to be a duty to plant and care for one or more trees, vines or shrubs; for in so doing will be found a source of future pleasure, of pride and benefit to our State and succeeding generations.

Done at the Capitol, in the City of Bismarck, North Dakota, this twelfth day of April, in the year of our Lord, one thousand hundred and ninety-three.

E. C. D. SHORTRIDGE,
Governor.

By the Governor:
C. M. DAHL, Secretary of State.

ALL PARTS OF OUR STATE HAVE ATTRACTIONS.

All parts of our favored State have attractions worthy of the attention and investigation of all who admire the beauty and wonder of nature or the industrial works of man. The famous Red river and its vast valley of the bed of the ancient lake Agassiz, and the land of harvests, rich and beautiful, is full of deepest interest to peasant, statesman and bard; the deep, broad Missouri, passing through the heart of the State, nourishing the green, bending trees, and forests along its shores, has beauty and grandeur in its power and sweep, and the James and the Cheyenne, silvering in the sunlight in onward flow, delight the eye and heart. And are these all the chief attractions? Nay, but the beginning. North, south, east and west they are seen, villages cities and cottage homes and farm lands wild and rich are seen far and near. And there is the Sylvatan Park, beauty's chosen place, the Red, the Chautauqua and the Militia Parks on the deep, broad, wide inland sea—Devils lake—shaded with forests green on shores, meandered and circled round. Far to the west, across the great Missouri, is "The Wild Land Park," known as the Bad Lands, where the fires of the ages, consuming the exposed coal, have fused the hills, rocks and clays into unequal, fantastic shapes and many colored hues, And away to the northeast, the Pembina Mountains, the historical hills, arise, a land-mark and an object of attraction to the denizen and the stranger moving across our garden lands in cars of luxuriance and ease. And near, about and far away across the virgin plain, the hills and mounts and trees, and waters flowing still, and the farms laden with grain and fruit, beauty, charms and signs of wealth, comfort and happiness, are seen to cheer, fascinate and bless all who behold these works of God and man.

THE TURTLE MOUNTAINS—THE NATURAL AMPHITHEATRE OF THE NORTH.

But there is another spot that the historians and authors will name with pleasure in years to come, and that is the Turtle mountains, placed midway between the Atlantic and the Pacific on the east and west, and the Gulf of Mexico and Hudson's Bay on the south and north. These mountains cover an area of near 800 square miles, being near 20 miles wide from north to south, and near 40 miles long from east to west, about one-quarter of the mountains being in Manitoba. The mountains consist of a succession of hills, rising like a great fortification over 400 feet above the plains. But there are numerous mountains, such as Boundary Butte, very high, "Mount Mokono," or Butte St. Paul, near 2,500, and Bear Butte, near 2,400 feet above the sea. The lakes are many, and some of large size, Lake Metegosle and Willow lake being amongst the largest. The former has a shore line of 22 miles and the latter from 12 to 15 miles. Many springs abound, soft, mineral, medical and artesian, and numerous brooks and streams thread through the highlands. The largest of these is Willow river, a branch and a feeder of the Mouse river. Much of the surface is covered with dense forests and small trees, or undergrowth. The trees are of good size and tall. Fifteen different varieties of native wild fruit, and also acorns, hazel nuts and filberts are found in this region. The land consists to a great extent of tall, rounded or broken hills, interspersed with hay meadows, rolling land, vales, dells and gorges, where leap the streams, nestle the lakes and pipe the song birds. This is the Turtle mountain timber reserve of North Dakota, known throughout the Union as the "Glacial Wilds of the West."

BEAUTY OF THE PICTURE PARK.

Nature has wrought with cunning hands in the Turtle mountain timber reserve, Around, about, over, across, on, in and through the embattled hills and mounts, the gurgling springs, silvery lakes, encircled and clothed with the towering forests, luxuriant and green, she has placed the impress of her enchanting beauty, and each place and nook and shade, where flowers bloom and the air is still, save when broken by the musical thrill of the song birds, breathe a calm and sweetness as if a divine presence ruled to bless all who seek retreat from the tumult and chafe of the busy world. This wild, fair spot, fittingly called by the people "The Picture Park," is and ever will be the home place of the author, thinker and the bard, the pride of the statesman and the patriot and the enchantment and joy of the people. And its economic purposes and blessings in the interest of forestal and cultural pursuits will continually demand the attention and vindication of the scientist and human benefactor. Hence it is clear to all minds that these forests and waters—mystic grandeur placed by Deific power in the glacial uplands, golden in the sunlight of heaven—should be perpetually preserved as a reserve to gratify the ideal, build up the villages to grow into cities at the mountain side, bring renown to the region, and to promote the prosperity and happiness of the millions to inhabit our great, rich state.

PLANT A TREE.

Plant a tree, oh father, mother, brother, sister; plant a tree, oh, friend of humanity; plant a tree, oh, Sylvatan for this and future generations, and thus aid the race in its upward reach toward the true, the pure and the divine life, wherein wisdom, truth, usefulness and joy shall have their fall fruition.

Plant a tree and listen to the song of the children's poetess, Lucy Larcom:

He who plants a tree
Plants a hope.
Rootlets up through fibers blindly grope;
Leaves unfold into horizons free.
To man's life must climb
From the clods of time
Unto heavens sublime.
Canst thou prophesy, thou little tree,
What the glory of thy boughs shall be?

He who plants a tree
Plants a joy;
Plants a comfort that will never clog—
Every day a fresh reality.
Beautiful and strong,
To whose shelter throng
Creatures blithe with song.
If thou couldst but know, thou happy tree,
Of the bliss that shall inhabit thee.

He who plants a tree,
He plants peace.
Under its green curtains jargons cease,
Leaf and zephyr murmur soothingly;
Shadows soft with sleep
Down tired eyelids creep,
Balm of slumber deep.
Never hast thou dreamed, thou blessed tree,
Of the benediction thou shalt be.

He who plants a tree
He plants youth;
Vigor now for centuries in sooth;
Life of time that hints eternity;
Boughs their strength uprear,
New shoots every year
On old growths appear.
Thou shalt teach the ages, sturdy tree,
Youth of soul is immortality.

He who plants a tree,
He plants love;
Tents of coolness spreading out above,
Mayflowers he may not live to see.
Gifts that grow are best,
Hands that bless are blest;
Plant, life does the rest.
Heaven and earth help him who plants a tree
And his work his own reward shall be.

FOURTH ANNUAL REPORT

OF THE

State Superintendent Irrigation and Forestry,

TO THE

GOVERNOR OF NORTH DAKOTA.

FROM

DECEMBER 1, 1893, TO DECEMBER 1, 1894.

Water and Forests

In proper proportions are indispensable in the economy of nature for man's highest good, and, therefore, intelligent, scientific and practical irrigation or the control of moisture by human agency for the best status of cultural pursuits, and the forestation of the State are subjects deserving of the fullest support of the State and the people.

LETTER OF TRANSMITTAL.

STATE OF NORTH DAKOTA,
Department of Irrigation, Forestry, Fish and Game.
BISMARCK, N. D., Dec. 1, 1894.

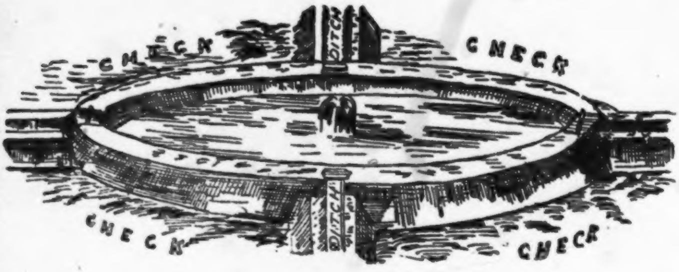
HON. E. C. D. SHORTRIDGE,
Governor of the State of North Dakota.

DEAR SIR:—In obedience to the requirements of the law, I have the honor to herewith present my Fourth Annual Report as the State Superintendent of Irrigation and Forestry of North Dakota.

Trusting the facts and views herein given may prove of value to the State and people, I remain

Yours respectfully,
W. W. BARRETT,
State Superintendent of Irrigation and Forestry

AN ILLUSTRATION OF AN IRRIGATION RESERVOIR.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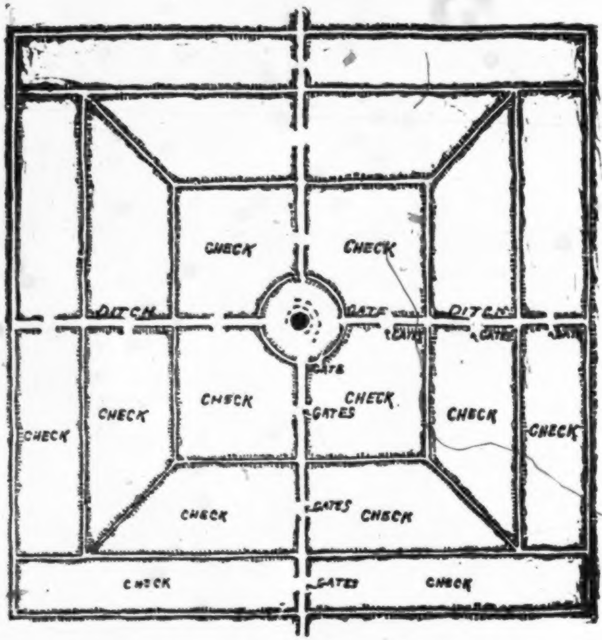
Sketch showing the appearance of a flowing well, with the surrounding reservoir for impounding the water.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Sketch plan showing reservoir round a flowing well and arrangement of checks and ditches for irrigating about one hundred acres from one well.

[The above plates were courteously loaned this department by Smythe, Britton & Poor Company, publishers of the Irrigation Age, Denver, Col.]

IRRIGATION.

IRRIGATION RESERVOIR.

A circular reservoir is built around the artesian well, the size to be regulated by the volume of flowing water from the well. The embankments to be made with sloping sides, the interior slopes being somewhat steeper than the exterior ones. This done, ditches are then constructed as shown in the diagram, gates being constructed at their heads.

To irrigate 100 acres, the reservoir should be 300 feet im diameter. The embankments should be from five to seven feet high. Four main ditches would be required, built at right angles to each other, which should be from four to five feet wide at the top, with a gentle slope inward, the depth to be from two and a half to three feet. The fall of the ditch must be as gentle as the ground will permit in order to prevent washing and erosion, yet sufficient to carry the water well to the lower end of the distributory. As well water is without sediment, the fall can be lessened somewhat. The aeration of the water in the well reservoir is most desirable, and after that conveyance by pipes would be more economical than by open ditches. The length of the four main ones proposed in the diagram would be about 1,700 feet each. Small laterals could be easily made to connect as desirable with the distributories, some of the means for regulating their flow appearing in the next article below.

METHODS FOR APPLYING ARTESIAN WATERS TO THE SOIL.

Artificial methods for controlling water for the promotion of the growth of fruit and grain can be traced back to the earliest ages. It was primitive at first, but in our time the inventive genius of man is continually devising new machinery or methods for lifting, storing and distributing water, and irrigation in its various phases has become one of the leading and one of the most important scientific studies of the present century.

We in North Dakota are more fully interested in the artesian irrigation system, than in any other, because it is the one best adapted to our State. The greatest artesian belt thus far explored is probably the James River valley in the two Dakotas. The irrigation system, which has its supply from artesian wells, has many features which makes it superior to other methods. The chief point of excellence being found in the fact that the irrigator owning and controlling the source of supply, becomes thereby independent of any corporation or joint company.

THE PRACTICAL VALUE OF WELLS:

The practical question that presents itself to the irrigator is this: If a considerable amount of money is expended for securing flowing water from underground sources, will it be a profitable investment? To arrive at a satisfactory answer to this question, the cost of obtaining water, the amount necessary to irrigate an acre, the method of distribution, the proper time for irrigation and whether crops will be damaged by the application of water, are matters that must necessarily be considered. A permanent supply of water during all the season is unquestionably a most vital question, and if the sources of supply are under the control of the land owner, his lands are surely of more value than when the supply is owned by others.

A perpetual water-right for 80 acres is estimated to be worth from $2,000 to four or more times that amount, the value being according to location, &c. It is found that many canals cannot furnish water to all parties, except at time of high water in the early spring—resulting in short crops and depreciation in land values. Hence it can be seen an artesian well becomes valuable in the ratio of the amount of its flow. Storage reservoirs would have to be constructed for the impounding of the output for the year. Then the value of artesian irrigation must be measured by the storage capacity and location of the land.

AMOUNT OF WATER REQUIRED.

The amount of water necessary to irrigate a given area of land depends to a great extent upon the kind or quality of the soil, the annual rain fall and the kind of crops to be grown. In Colorado it is estimated a continuous flow of 450 gallons per minute is needed to thoroughly irrigate 45 acres throughout the irrigation season, being from 90 to 100 days. The amount of flow during that time would be sufficient to cover the land 40 to 50 inches deep. In Italy, the amount of water is estimated at a flowage of 450 gallons per minute, as necessary during the season for a tract of 70 acres. In that kingdom the people have had 600 years of experience, and have an annual rainfall of 36 inches as an aid to irrigation. Practical irrigators in the James River valley, according to experience, are justified in their assertion that a flow of 2,000 gallons per minute from a well will furnish an abundance of water for 640 acres of land.

DISTRIBUTION OF WATER.

The irrigator must have an intelligent knowledge of the soil and its formation in order to make a proper application at the right time and the most desirable manner.

It becomes necessary to secure a reservoir site where the least expense would be incurred in carrying water to the different fields. Reservoirs may be built in an elliptical or circular form. The size may vary from 4 to 10 acres, according to extent of land to be irrigated. The embankment should be six or seven feet in heighth, the slope in the inside one to two feet, and one-half to two feet on the outside, with a base of 28 to 30 feet in width and near four feet at the top. The same to be constructed of soil excavated from the interior of the reservoir.

The mains run from the reservoir and are laid out to correspond with the general slope, and are constructed along the highest side, where the form of the land will admit of mains to be constructed. Branches may be made to cover the entire tract. The fall for a convenient narrow main is four feet to the mile, but if such a fall cannot be secured the main must have greater width. A ditch with a four foot fall would need be five feet wide and one and one-half feet deep to carry a flow of 2,000 gallons per minute or a quantity sufficient to irrigate 640 acres.

In passing over low lands embankments are thrown up or flumes made to conduct the water over. At points where the soil is of a clayish nature a grade similar to a railroad bed is built up, where after settlement of the soil, a trench is formed through the center, having a carrying capacity equal to the main. If the soil is of a loamy kind or somewhat sandy, a dyke must be thrown up on both sides of the main. In either case, the slopes must be made to conform to the reservoir plan.

A flume eighteen inches wide and one foot deep, provided the fall is sufficient, will carry the water flowing from an ordinary well. In constructing flumes the capacity for carrying must be reckoned proportionate to the fall, as to the mains and laterals.

Laterals conduct the water from the mains to the various fields. Usually they are made for use for but one season. The distance apart ranges from 50 to 150 feet. When there is a slope of 4 to 20 feet per mile, the laterals run diagonal to the general slope. These laterals are made by turning a single furrow, the soil being thrown to the lower side. The laterals are made permanent by turning two furrows.

METHODS FOR VARYING SURFACE.

To irrigate sloping lands the water is turned on two or three laterals at a time. Dams are put in near the mains, and the water from each lateral finds its way over the land until it connects with the one below. Then another dam is constructed at a point below the other, and the water flows over other parts of the land. During this time, the operator should keep a close watch of the higher parts, and that the obstructing dams are placed so as to raise the water as needed.

This work is continued until the land is well irrigated, and thus on in the other laterals, until the whole field has been thoroughly moistened.

It is more difficult and more expensive to irrigate level lands. These levels are built up and trail across the land so as to spread the water over all parts of the fields. Then again wide ditches or mains pass through the land lifting the water above the levels where it flows through the laterals upon the soil. This last plan is the most feasible and it involves the necessity of a reservoir. It is found to be difficult to run water more than 20 rods from the mains on a level surface.

As the water will run but a short distance on level land a system of ditches will have to be constructed running parallel through the field, near 40 rods apart and about 20 rods from the sides of the fields. These find connection with the reservoir. The mains and ditches should be elevated not less than two feet above the level of the land, whereby the water can be raised one and one-half feet above the surface. These are formed by two furrows throwing up a bank on both sides. The best instrument to use is a double mould-board plow. The laterals must be made to extend from one ditch to another.

The water, in irrigating from such ditches, is made to turn into two laterals, the farther ends of which are dammed. Over the strip lying between the laterals the water finds its way, when it is turned into other plots of land. The banks being raised, gates or boxes are necessary in order to let the water out of the ditches into the laterals. These gates are in construction similar to a culvert box, and they are set securely in the ground. Wings are needed on either side to guard against washing, and boards are driven under the box to prevent under washing. Eddies are formed by the water running out of the head gates, and tend to wash out under the gates. Then a wider box is employed at the end of the gate box. Thus the undermining process is prevented.

Dams or checks must be put in the mains in order to conduct the water into the laterals. The usual method is to throw a bank of earth across the mains. In wide mains permanent checks are made by building of earthen dams.

PUMP.

There are so many styles of pumps used, some of which would only be suitable for special localities and conditions, that to recommend any particular pump would be unfair, not only to makers, but those contemplating using the same. Sixty-nine per cent. of the water works of the United States pump either a whole or a part of their supply.

For raising water for irrigation of wells, streams, lakes or reservoirs, chain or link elevators are now being used and give satisfaction. They handle large quantities of water with small expenditure of power; can be operated by horse, steam or water pump and will pump from 300 to 2,200 gallons per minute.

An improved patent water elevator is here briefly described. It differs materially from other elevators as to its construction, working as it does on an inclined railway, and carrying cups in very close proximity to each other, propelled by an endless chain, and are emptied at such an angle as to give a continuous stream of water, return empty, and are again filled automatically without any strain on the elevator or slacking of its speed.

A farmer having only a quarter section of land can own an elevator and irrigate his farm by the use of one horse with the ordinary spur-wheel horse power, and the large farmer or ranchman, by the purchase of a large elevator and a small increase of power, can have water on any part of his property.

Pulsometer steam pumps having a capacity of 600 to 120,000 gallons per hour are used in raising water where the source of supply is from wells and beds of rivers, or from other positions awkward for irrigation purposes. The pulsometer pump is specially suited for use by unskilled labor on account of its simplicity and freedom from derangement. Water, if containing 60 per cent. of mud or sand, can be readily pumped from wells or streams by the pulsometer pump.

The expense of running these pumps is inconsiderable. A number eight size, discharging 45,000 gallons of water per hour, which was used by ranchers and fruit growers on Snake river in Washington and Idaho, was run at an expense of about $1.50 per day.

Centrifugal pumps are very effective for raising water and of any size and capacity; such a one was used at the Centennial in Philadelphia and was able to throw 100,000 gallons per minute. That would be sufficient to supply about 7,000 acres of land with water for continuous irrigation. The principle upon which this pump works is that of the common propeller of the steamship. An ordinary propeller shaft is enclosed in an iron pipe and is rotated by means of a pulley and a belt from an engine.

The gauge pump is used extensively in the west to good advantage.

THE WINDMILL IRRIGATION SYSTEM—ITS PRACTICAL UTILITY—IN DEFENSE OF WINDMILL IRRIGATION.

Amongst the various plans of irrigation finding advocacy at my hands was the Windmill Irrigation System. This I have presented to the press, and in my former report (1892), wherein considerable space was devoted to the presentation of this important system, wherein was given the experience of those who had applied the same, their success and profits, etc. Valuable tables were also given as to the velocity and pressure of wind, capacity of pumps, and the pumping capacity of wind engines, all of great value to the experimenter.

CHEAP AND PROFITABLE.

I consider that for North Dakota and the other states of the union, the Windmill Irrigation System is one of the very best that can be devised, at small expense, for a general application, assurance of crops and profits, in the cultivation of small tracts of land.

IMMENSITY OF THE UNDERFLOW OF WATER IN NORTH DAKOTA.

The phreatic water, or underflow, of our State is very abundant. At first thought the amount of water found underground is surprising, but when we consider the great absorbant qualities of our soils, imbibing, in my judgment, at least one-half of the rainfall over the entire State, the quantity discovered beneath the surface but confirms the philosophical and common sense reasoning in relation thereto.

VAST AMOUNT OF RAINFALL IN NORTH DAKOTA.

The reasonableness of this conclusion is made apparent by the fact that the precipitation in North Dakota, on an average, is eighteen (18) inches per annum, equal to 23,246,084,544,561 gallons, one-half of which doubtless goes to feed the underground waters. Evidences seem to indicate to the studious investigators that such waters are almost inexhaustible. Certainly it is true of many parts of our State.

OUR COMMON WATER WELLS.

I am inclined to the opinion that the average depth of our common water wells is not far from 30 to 35 feet. I am acquainted with many of this uniform depth, though throughout the State they vary from 10 to 75 feet, and sometimes deeper. The source of water in the shallowest wells is generally found in layers of quicksand, and occasionally in shale or clay. But in the deeper wells the blue clay is passed through when the water is almost invariably found, and in abundance, in the coarse sand or gravel, much water worn just below the clay, often called "caprock," and as such waters are generally of an artesian nature, they often rise and remain almost stationary 10 to 20, or even 30 or more feet, as is often the case, above the point of contact. And I will here say generally the waters found in our wells are pure, healthy and most agreeable to the taste.

CHARACTERISTIC WELLS.

I will name a few sample wells. In 1892 I put down a bored well on my Sylvatan ranch in Coulee, Ramsey county, and near Church's Ferry, N. D., to a depth of 35 feet, going five feet below point of contact into the coarse gravel, and it rose 18 feet in about three minutes. In another well, sunk by a neighbor three miles away, the water rose 30 feet in five minutes. My own well, named above, furnishes a sufficient amount of water for 300 sheep, seven horses, six cows and calves, and for all domestic purposes. Ole Johnson sunk a well in Irvine, Ramsey county, 3x3 feet for 26 feet, and then a boring with a two-inch auger was made 26 feet more, when the water rose 38 feet in one and one-half hours. From that well Mr. Johnson waters from 150 to 250 head of stock each day, and the supply remains undiminished. A few years ago John Gill put down a well in Coulee, Ramsey county. The excavation was four feet in diameter and 40 feet deep, with boring below with a small auger to a distance of 20 feet more, and in a few hours the water rose 36 feet. The water has its source in quicksand sand and it is as sweet and pure as any water of the earth. On cleaning out the pipe a few seasons ago the water rose 42 feet. This well furnishes sufficient water for a very large number of horses and cattle. Mark Henderson's well in Towner county is nothing but a gas pipe one and one-half inches in diameter, driven into the ground about 10 feet, which supplies the farmers around for many miles. Occasionally an excavation of 75 or 85 feet, or sometimes more, must be made before reaching the water, which in such cases almost inevitably rises to a great height. A few years ago Hon. Frank Palmer put down a well near his home at Fort Totten. The boring was made with a 14-inch auger. The surface consisted of soil followed of yellow clay for seven feet, when quicksand was encountered for 35 feet. When at a depth of 42 feet from the surface the hard pan was reached consisting of blue clay and shale or slate rock, wherein the water was found. The galvanized iron curbing was put in from top to bottom. The water is pure and most palatable to the taste and stands 24 feet high throughout the season, though by means of a pump a very large quantity of water is daily elevated for stock and the use of the family and the inhabitants of the place.

A WELL AT SMALL EXPENSE.

Nearly every farmer in North Dakota could sink and stone up a well in a short time and not pay out a dollar for the work. This could be done by himself and boys, or by exchange of work with his neighbors.

IMPORTANT FEATURES TO BE OBSERVED.

There are many points to be considered in erecting a windmill for irrigation, among which I will enumerate the following: The proper elevation of the reservoir or tank in order to get a flow sufficient to reach all parts of the land where the water is needed; the cost and the capacity of the reservoir for the object in view; the nature or perosity of the soil and the number of gallons or cubic feet of water necessary for each acre foot on the various kinds of crops, for some require more than others (an acre foot is an acre of land covered in all parts with water to the depth of 12 inches); the number of times the ground should be irrigated and the amount of water that should be applied at each wetting in order to give the best and most profitable results, which can best be learned by experience, observation and careful study; the necessary height of ground; the size or diameter of the mill wheel, the pump, pipe, attachments, etc., and the lifting power of the mill, geared to a certain number of strokes per minute, and the amount of water which will be discharged per hour; the quantity of water which the well will yield; the height to which the water must be lifted, and the question of the cost of the entire plant and its profitableness must be considered. Or, putting most of these things in a condensed form; how much water of a certain depth can be lifted in a certain length of time at a certain number of strokes per minute with a mill and pump of a certain size and make; the probable amount of water to be furnished by the well; and a certain amount of water being lifted and impounded in a reservoir; how much land will it serve successfully; cost of the entire outfit and the probable profit of the venture.

HEIGHT OF RESERVOIR.

The well should be sunk on elevated ground, such as can be found on most of the farms in the State, or the reservoir elevated some distance above the surface so the water may be easily carried in the ditches and laterals to all parts of the crop. Even 18 inches above the surface will be sufficient for this purpose.

AMOUNT OF TIME OF IRRIGATION.

Much discretion must be exercised in the application of the water to the soil in order to be assured of good and profitable crops. The amount of water needed depends upon the kind of crops, some plants taking up more moisture than others, the nature and condition of the soil and the season or state of the weather. It is found, as must seem reasonable, the drier the soil and season, as during the drouths, the more water is required. The total amount of water to apply on various kinds of crops on an average in our State, according to the best light obtainable at this time upon the subject, is one-half acre foot or six inches in depth. As a rule, one and one-half to two inches of water, evenly distributed at each wetting, is about the needful quantity. Two inches of water is equal to 55,040 gallons per acre and one inch of water is equal to 28,520 gallons per acre. The wetting may vary from 10 to 20 days according to condition of the soil and the weather at that time of application. The irrigator should see the soil is wet artificially or by precipitation or other natural methods just before or immediately after seeding. Then some claim that instead of frequent wetting it should be done in June or July, and later if necessary. The water can also be applied to good advantage after the removal of the crop in summer or fall. This way of irrigation, particularly in the fall, has been found by experience to put the land in prime condition for the next season's crop.

SIZE OF MILLS.

Less the distance to be lifted less the power acquired to elevate the water. Seemingly, as a rule, a 16 or 17 foot mill of most of the various makes would be required for the best practical work in lifting water a distance of 30 feet for the irrigation of 10 or 15 acres, although it is claimed that some mills of a good make of a less diameter would do the same amount of work. To lift the water 10 or 12 feet probably a 12-foot wheel would furnish sufficient water for 10 acres.

COST OF MILLS.

At this time I am not prepared to give the exact cost of mills in this section. The cost of course depends upon what is furnished, such as the size of wheel, height of tower, size and make of pump, etc. But for mills capable of lifting 25 to 30 feet one agent has quoted the following prices: Twelve-foot windmill, with steel frame all complete, near $105.00; 16-foot windmill, with steel frame, all complete, $250.00.

WINDMILL IRRIGATION, EAST AND WEST.

For a number of late years the windmill system of irrigation has been successfully practiced in numerous states. In the East they are used for garden truck, in Florida and Louisania for irrigation of fruit trees, etc. In the latter state they serve the double purpose of one time pumping the water on, and again pumping it off from the soil, when the desired point of saturation has been reached. And they are used quite extensively in the West for irrigation of orchards, nurseries, vegetables and small fruit.

In the January, 1894, number of the Irrigation Age, published in Chicago, Ill., I find an instructive article from the pen of B. A. McAllister, land commissioner of the Union Pacific Railroad company, who has investigated this system. From this paper I glean some facts worthy of attention. By correspondence Mr. McAllister secured in the neighborhood of two hundred names of parties who have made a practical application of this method of irrigation. The experiments have proven successful and a number of the operators enthusiastically endorsed their plan of applying water for horticultural productions. These two hundred windmill operators were located in western Nebraska, southeastern Wyoming, northeastern and east central Colorado and Kansas.

CAPACITY OF MILLS.

F. M. Goodhue, secretary of the Goodhue Wind Engine Company, of St. Charles, Ill., says. "The 17-foot mill with an 8-inch cylinder irrigation pump will lift 120 gallons of water from a well 30 feet deep in a space of one minute, going 7,200 gallons per hour, or 172,800 gallons per day. Now suppose we calculate on the mill running but half the time, though careful observation seems to indicate that a mill in North Dakota will run a larger length of time, this would give 86,400 gallons every 12 hours out of the 24. This would put an inch of water on every 21 acres a week and 84 acres in a month. And putting it in round numbers it would take less than two months to cover 160 acres one inch deep and nearly 12 months to cover the same land six inches deep." Thus it can be seen by these figures, two 17-foot mills running half of the time, could cover 160 acres of land, with water six inches deep, in little less than six months, or the crop season. This is from a well 30 feet deep, but for a less depth the mill would lift a proportional larger amount. It must not be forgotten there must be a large supply of water to cover 160 acres one inch deep, to-wit: 4,403,200 gallons.

VALUABLE DATA.

Prominent windmill pump companies furnished Mr. McAllister with certain data, from which I condense the following facts:

One-horse power will raise a five-inch column of water 100 feet; six-inch column 70 feet, and an eight-inch column 40 feet. Additional horse-power will elevate the water in direct proportion; a 10-foot mill will develop one-half of one-horse power; a 12-foot mill three-fourth horse-power; a 14-foot mill two-horse power, and each additional two feet in diameter of mill develops practically an additional of horse-power up to a 30-foot mill which develops eight-horse-power. It will be remembered a horse power is a power of any kind that will raise 32,000 pounds avoirdupois, one foot high, per minute. There the smallest mills cost $40 and increase in price in proportion to the size to the largest, costing near $400.

Mr. McAllister also learned that a five-inch pump geared 48 eight-inch strokes per minute will discharge 1,860 gallons of water per hour; a six-inch pump geared in the same way will discharge 2,760 gallons per hour, and an eight-inch pump will discharge 4,860 gallons per hour.

DUTY OF WATER.

Different soils varying in porosity and imbibing qualities require different amounts of water. And as heretofore stated, the quantity of water needed varies according to the kind of crops, the state of the weather, etc. Hence, from the very nature of things it is reasonable to suppose there can be no uniform standard for the duty of water; and actual experiments in various states prove this conclusion is correct. Under the supervision of L. T. Maxwell, the state engineer of Colorado, it was discovered by careful measurement made by numerous irrigators of five of the large irrigation districts of that state, that the average depth of total water applied was 13 inches. At the Utah experiment station, J. W. Sanborn, director, Logan, Utah, it was learned by an application of water for 100 days on all various tracts of lands averaging 256 acres that the average depth of water applied was 14.4 inches.

In 1891 the Consolidated Land and Irrigation company of Huron, S. D., one of the most practical and successful concerns in the west, applied but six inches of water, and all at one wetting, to the soil, resulting in a yield of 53.20 bushel of wheat per acre, of 61 pounds per bushel, with a No. 1 Northern grade, giving an increasement over non-irrigated land of 15 to 25 bushels per acre.

AMOUNT OF WATER PER ACRE IN NORTH DAKOTA.

As the soil of the two Dakotas are similar in their nature, it is reasonably plain from the above facts that a total application of water to the depth of six inches is all we need for various crops in our State. And our own best irrigators share this opinion.

A RESERVOIR INDISPENSABLE.

A reservoir or tank is an almost indispensable requisite in connection with the windmill irrigation system, as well as the artesian well system. The reservoir being filled by the work of the mill, there is a volume sufficient to flow through the distributing trenches sufficient in amount to flood the squares or blocks as may be desired. Where the water is pumped direct into the ditches it is lacking in volume to move rapidly and soaks into the ground too quickly near the mill, and thus much is wasted. The water running from the reservoir has volume and force, or pressure, and is then easily carried where desired and made to work to the best advantage. It also saves much time and adds very largely to the duty of water. Every irrigation plant, that is to say, the artesian or windmill plant, is incomplete without a reservoir or tank.

HOW TO MAKE A RESERVOIR.

A reservoir can be quickly and cheaply made in the following manner: Lay off your land in any desired shape and with a horse and scraper remove one to one and a half feet of the soil, and with the dirt thus accumulated build up an enbankment on all sides to a height of two, three or four feet as may be desired. The interior of the embankment should slope a little steeper than the exterior. It is well to make the embankment as compact as possible. This can be accomplished by having the embankment trodden by men, or, what would be better, by horses. It would be wise to let the embankment settle for a few days—the longer the better. In order to prevent seepage when you begin to fill the reservoir, commence tramping with horses as fast as the water spreads over the bottom until there is obtained a loblolly or mud near two or three inches deep. This settling into the interstices or pores of the ground will practically stop all the seepage. No straw or manure should be placed in the bottom of the reservoir if the object is to have pure water such as is needed for stock and fish. It is calculated two men and a team can make a reservoir 100x100 feet and four feet high in eight or nine days, or less time. If it is desired to prevent any loss by seepage, then proceed as follows: Clean out the inner surface by sweeping out, apply hot coal tar with a mop to the inner surface on the bottom, and as far up the sides as may be deemed best. On this put a sprinkling of dry sand, being careful to apply at once when the tar is hot. When cooled and sufficiently hardened, sweep off clean, as before, and follow with another coat of tar and a sprinkling of sand, and follow this with another application. See that the tar is properly boiled down. Having complied with these rules, you will have a tough, hard and compact surface, which will be lasting as stone, and unaffected by heat or cold. Should it chance to crack by the settling of the banks, it can be easily mended by the employment of more hot tar and the sprinkling of dry sand.

USE FURROWS FOR APPLICATION OF WATER.

In irrigating small fruit, berries and a great many kinds of fruit trees, the use of furrows or small ditches instead of flooding the land, it is claimed by experienced parties, is the most desirable, as by so doing nearly one-third of the water is saved that would otherwise be required to flood the land.

A reservoir 100 feet square and four feet deep would contain 40,000 cubic feet or about 300,000 gallons of water. One cubic foot equals near seven and one-half United States liquid gallons, or, to be exact, 7.58.

PRACTICAL USE OF IRRIGATION BY WINDMILL POWER.

Let us see what has been actually accomplished by irrigation through the use of windmills.

W. B. Grace, of Garden City, Kansas, states: My reservoir holds 6,000 barrels of water. I made it by scraping out the ground to the depth of about one foot, and the dirt thus obtained made the banks some four feet high, all of which I did in a few days with one horse and scraper. My five-inch pump throws one gallon of water at each stroke and a 10-foot windmill runs it and makes 60 strokes per minute in an ordinary wind. I irrigated four acres last year (1892) and could have watered two or three times as much if my ground had been ready. My young orchard made a rapid growth from this irrigation and I marketed in small fruit, garden stuff, etc., $500 from the four acres.

I. L. Diesem, of same place, writes: I run an eight-inch Gause irrigation pump with a Halliday windmill. Reservoir is 90x180 feet and five feet deep. Pump lifts two and one-half gallons of water at each stroke. Can successfully irrigate from 10 to 15 acres. Have 300 German carp in my reservoir and all doing well, and I take ice from my reservoir filling a large ice house.

J. F. Monson, of Julesburg, Colorado, states that he is irrigating 8 or 10 acres of land with two windmills raising a three-inch stream into a reservoir 80 feet in diameter and 4½ feet deep. Cost of plant, $225.

A Nebraska farmer makes a statement to the following effect: His windmill plant run by a 14-foot wheel with an eight-inch Gause pump throws 4,400 barrels per day in a medium wind. He operates two reservoirs, one 60x150 and one 80x150 feet. He waters 10 to 15 acres, and thinks the acreage can be increased by applying the water to some of land during the winter season. The water is lifted 17 feet, but the pump, he claims, can easily lift it 25 feet.

Col. Edwin S. Nettleton, chief engineer of the irrigation underflow investigation of 1891, speaks of two enterprises in Kansas in his report from which I glean these facts. A 10-foot windmill was used to raise the water 10 feet, the water being stored in a reservoir 40x60 feet and three feet deep. The reservoir was constructed on top of the ground with embankments of earth.

The pump was a five-inch Gause pump, which was attached to four drive wells which reached water seven feet below the surface. We have numerous underflows of this nature in North Dakota, where water is found from 6 to 10 feet, where the same principle of drive wells can be easily and successfully applied.

The water was made to irrigate four acres of garden vegetables and small fruit; cash outlay, $135. Income from the garden, $500 over and above the amount consumed by the family.

The other instances: Size of windmill, 16 feet; raised the water 14 feet and stored in reservoir 55 feet wide, 178 feet long and 4 feet deep. An 8-inch Gause pump used and with a fair wind pumped 16 inches deep of water into the reservoir, being about one-third of an acre foot; cost of plant, $500. Size of vegetable garden irrigated, seven acres. The proprietor concluded 12 acres fruit trees could be irrigated, besides a large amount of vegetables.

INTENSIVE CULTIVATION.

There is need of a revolution in farming in the West. Not only more diversity, but a more intensive culture is demanded. This involves the necessity of the concentration of capital and energy, upon small tracts of land, and the wise employment or use of water or moisture from some source, and in some form, without which, in all time, no crop has, can or will be successfully, or even imperfectly, produced in any division or climate of the earth. Intensive farming, embracing the production of grain, fruit and vegetables of good quality and large quantities, on a small space of ground, has occupied human attention for many ages in various parts of the world. Evidence of such improvements in farming may now be seen to a great extent in the irrigation enterprises in the West, East and South of our union, where the profits amount to millions and millions of dollars per annum. These are intensive in the sense that each tract, small or large, involved greater concentration of capital, labor and intelligent cultivation, in connection with the application of water, than are given to non-irrigated lands, dependent for moisture upon the rainfall.

NOT THEORY, BUT PRACTICAL RESULTS.

What has been given in this article is not wholly theory, but along the line of experience and practical results. And it must impress the mind of the thoughtful, that though there is probably much yet to learn, as is true of all new, and also of all old, ideas, nevertheless the Windmill Irrigation System contains all the favorable conditions needful for good results in the way of certainty of crops, even through the seasons of hot winds and burning drouths, and a most liberal and remunerative profit on the investment.

THE OLD WAY OF FARMING IMPOVERISHING.

The North Dakota farmer may be disinclined to abandon his accustomed mode of cultivation, by ignoring the control and application of water to insure a certainty and remunerative profit at farming, and may continue on in the old, hard way, dependent, in the terse and impressive language of Prof. Van Dyke, upon "*rain, the miserable subterfuge for irrigation*"—fickle, uncertain, unreliable and generally absent when and where needed. If drouthy conditions continue to prevail, and such will be the fact from time to time, unless forestry and the broad principles of irrigation, or the proper and scientific application of water for cultural pursuits shall be successfully unfolded in the semi-arid West, then the farmer operating under the dry-culture system must meet with losses by the reduction of grain to four to five bushels per acre, as has been done in large sections this year, or to nothing but a meagre crop of weeds as in 1889, tending to the loss of capital, impoverishment, want and ruin.

WILL TIDE OVER THE DROUTH.

But it would seem wise, if each farmer can raise a few dollars, for him to put in a windmill irrigation plant and the ten or fifteen acres cultivated therewith would tide him over the seasons of drouth and also give him a handsome profit each successive year of from $500 to $800, according to conditions and the amount and quality of brain and handwork involved therein.

MANY WINDMILL PLANTS.

The limit of the waters known as the "underflow" or "phreatic" of North Dakota are not known. But quantity is immense and seemingly point to the fact that it is sufficient to furnish an ample supply of water for a windmill irrigation plant on every five acres or less of land throughout the State, where such waters are found, and no failures have been yet discovered in our State, and probably all other semi-arid states would furnish a similar supply of such waters.

IMMENSE ARTESIAN FLOWAGE IN NORTH DADOTA.

Water is wealth and we have an immense capital of this kind in North Dakota—the element which wisely used cannot but conduce to the most practical and beneficent good of the country and its toiling sons. Then why should not all of our waters be impounded in reservoirs or used direct from their source and utilized for irrigation purposes? Let us investigate a little and ponder upon what we discover: The water issuing from the flowing artesian wells and the artesian springs of North Dakota amounts to 4,432,000,000 gallons per annum. Using one-half acre foot or six inches deep, evenly distributed, of water per acre, which quantity is all that is necessary to produce the greatest amount and best quality of grain from the soils of our State, this supply of water, named above and now going to waste, would of itself irrigate over sixty-seven ten-acre lots of land in every organized and unorganized county in our commonwealth.

THE SOURCE OF OUR IRRIGATION SUPPLY.

The source of our water supply for irrigation purposes we would find to be:

First—The immense amount now flowing from the earth in the form of artesian wells and artesian springs, as stated above.

Second—Flowage from common springs.

Third—Impounded rain-water.

Fourth—Waters from our rivers, streams, lakes, sloughs, etc., in their normal condition.

Fifth—The inexpressible quantity of water to be secured by means of common wells from the great "underflow," the same to be lifted by hand, horse, steam or wind power, etc.

Sixth—The vast volume of water that can be obtained by more artesian wells to be put down in the great Dakota basin, the largest in the world, and covering most of our State.

Seventh—The largest conservation through the use of reservoirs, canals and refilled lakes, of the surplus spring floods of our great and small rivers, such as the Missouri, Yellowstone, James, Cheyenne, Red, Knife, Heart, Cannon Ball, Mouse, Pembina, Park, Turtle and others, together with their branches.

A.—The surplus spring waters of the Missouri alone, if properly controlled (doubtless these waters taken from near the mouth of the Yellowstone could be successfully conducted across the State—refilling and perfecting on its way the great inland reservoir of Devils lake) would, under judicious management, so irrigate the lands of North Dakota that its products would add millions of millions of dollars during the years to the wealth of the State, over and above the yield to accrue, as now, from non-irrigated lands.

B.—Lieutenant Maury estimates the discharge of water of the Missouri river into the Gulf of Mexico is *one hundred and seven (107) cubic miles*—107 miles long, 107 miles wide, and 107 miles high—every successive year.

THE POSSIBILITIES OF IRRIGATION IN NORTH DAKOTA.

Let the reader review our source of supply of water that may be used by the employment of sufficient capital, labor and scientific skill for irrigation purposes, and with ample amount of water where needed, all the land of North Dakota can be irrigated, though in some parts of limited areas, comparatively speaking, the expense would not warrant the undertaking. The sources of our water supply, outlined above in paragraphs 1 to 7 and A and B inclusive, will give some idea of the possibilities of irrigation in our enterprising and progressive State.

OTHER USES OF THE WIND MILLS.

It is well to remember wind mills of good make and quality can be safely and easily, as well as economically, operated in North Dakota. And besides irrigating ten to fifteen acres of land the right mill can be used to furnish water at a great saving of labor and time for stock, domestic use, for fish ponds, ice ponds, grinding feed, running all manner of machinery at the barn and in the house, such as sewing machines, churning, etc. I know of numerous parties in our State who contemplate putting in, in the near future, wind mills for the irrigation of small areas and general farm purposes at the same time.

THE GARDEN PARADISE OF THE AMERICAN UNION.

Irrigation in all its varied forms is worthy of and should receive the profoundest study and aid of all the lettered and unlettered citizens of our commonwealth, for herein can be found the elements which, under scientific enlightenment, inventive skill, labor, capital, and proper management, would, of a certainty, give us a dense population, wealth, and under proper training, culture, peace and happiness, born of a new order of civilization, where water and forestry holding their rightful position as foremost in the world's great economics would, in connection with co-relating causes, make our dear State the garden paradise of the American union.

THE BEST OF TESTIMONY.

The writer of this letter, Judge D. M. Frost, is one of the leading influential citizens of Kansas, and his statements can be wholly relied upon as trustworthy and true:

UNITED STATES LAND OFFICE,
GARDEN CITY, Kansas, December 2, 1894.

HON. W. W. BARRETT,
State Superintendent of Irrigation, etc., Church's Ferry, North Dakota:

MY DEAR SIR:—Your esteemed favor of Nov. 10th was received in due time, but found me sick and confined to my bed, my first outing being taken on the last day of November, so this must be my excuse for not answering your letter sooner. So far as I can do so I gladly answer the questions asked, or shall be pleased to give any other or further information on this all important question of irrigation. It is an issue with us on the western plain of Kansas, and we truly and honestly believe that the individual irrigating system will prove the ultimate redemption of all this section. The number of windmills used for irrigating purposes in this county (Finney) is upwards of 125. By this I mean 125 individual pumping stations by windmills into reservoirs and water used wholly for irrigation purposes.

2d. Three-fourths of which were constructed within the last 12 months.

3d. The popularity of the system is such as to induce many others to erect mills and pumps and construct reservoirs for the purpose of farming all the way from 5 to 50 acres by irrigation.

It will pay a good profit on an investment of $20 per acre in cost of erecting plant, and in many instances in this county parties claimed, after harvesting their crops off of five acres of ground, that they had raised enough to keep them a year and cleared their pumping plant besides.

So far as I know there is not a single objection that can be raised against an individual windmill pumping irrigation plant, but hundreds of reasons can be assigned in its favor. I possess a plant which I have used one season, covering 20 acres, consisting of two windmills and three pumps, which will water 14½ feet and give me about 11,000 gallons of water per hour. I simply wouldn't be without it for double the cost of the plant, which was about $500. It is a sure crop on everything planted, while without them there is no certainty of one crop in seven. We are striving for aid by the Federal Government in helping our people to locate our hidden waters, underflow, artesian waters, etc., by surveys and experimental tests which we believe Government should make for us, showing to us the amount of water available for irrigation purposes. We can no longer depend on our flowing streams as they are drained by irrigating ditches on the west of us, so we must look to the so-called underflow waters, or artesian waters and storage systems, collecting the storm waters. We also hope for some State aid and legislation favorable to the cause of irrigation. I notice that your State has a state superintendent of irrigation. Can you send me a copy of the law creating said office and duties of superintendent, although I see forestry, fish and game linked with the same office. Anything that you may be pleased to send me in this line will be much appreciated.

I notice another query in your letter that I came very near overlooking, and that is how much land can alternately be irrigated with a 12 foot wheel. On a 15 to 20 foot lift a 12 foot wheel attached to a ten (10) inch pump and cylinder—(10) in. cylinder —will raise enough water to irrigate 10 acres, and ought not to exceed in cost $200, mill, pump and reservoir complete.

My choice of mill is the Ideal Irrigation Wind Mill and Stone Pump. Pump made by P. G. Stone, of this city, who makes the strongest, simplest and cheapest pump on the market.

Hoping that I may have at least answered a portion of your questions, I remain

Very truly,

D. M. FROST.

THE NEW IRRIGATION METHOD.

Irrigation by means of wind pumps in Finney county, Kansas, has attracted the attention of farmers and fruit growers from all parts of the West and during the past summer there have been a number of excursions from various points, bringing visitors to investigate this method of irrigation. That it is no longer an experiment is attested by the fact that there are at least one hundred pumping plants now in successful operation in Finney county, and it has opened up an industry in the growing of fruits and vegetables unequalled in any portion of Kansas. Some of the finest orchards to be found in the West have been grown in Finney county entirely by the use of wind mills, and there are a score of persons who have realized from $100 to $200 per acre from the products of their orchards and gardens this season.

The above illustration is from a photograph of the pumping plant and reservoir of Mr. L. L. Doty, one mile east of Garden City, and he has the following to say in regard to this method of farming: "A good windmill is the cheapest power we have, at the present time, for raising water, and there are very few places in Finney county with a good windmill and pump but what enough water can be raised during the year to successfully irrigate from two to 40 acres of fruit and crops, and the family in this county with a two acre truck patch is nearly heeled, and the family with 40 acres in orchard, Alfalfa and truck, has a gold mine. To show what can be produced on a small piece of land, in a poor year at that, I will say that on my place one mile east of Garden City, the past season (1893) was one acre of cabbage that produced over 9,500 pounds at 2½ cents per pound, not a fancy price, brought $237.50, besides plenty for two families to eat; and on my 40 acre farm the past season was raised the following amounts: 13 acres Alfalfa, 1st crop, 10 tons, $50.00. Second crop, straw, 10 tons, $30.00, 120 bushels seed at $4, $480. Sweet potatoes, 9 acres, 1,200 bushels at 60 cents, $720.00. Cabbage, one acre, 9,500 pounds, 2½ cents, $237.50. Irish potatoes, 50 bushels, $50.00. Tomatoes, ¼ acre, 80 bushels, $80.00. Watermelons, one acre, 600, average 10 cents, $60.00, and gave away and ate hundreds. About 26 acres in crop, the rest of the 40 acres in orchard, grove and public road, yet the grand total is over $1,725.

APPLIED IN NORTH DAKOTA.

Hon. A. L. Hanscom, senator from McHenry county, lives five miles southwest of Towner, McHenry county, N. D. His farm is located on Mouse river, where he put up a windmill for irrigation purposes on or near August 1, 1894. The mill is eight feet in diameter; height of tower, 40 feet. It is made of wood. The mill is about 75 feet from Mouse river, lifts the water 12 feet and throws a barrel every eight minutes. The water was applied to the land late in the season, but the result was favorable. Mr. Hanscom irrigated near half an acre, and raised at the rate of about 300 bushels per acre. Next season this gentleman intends to irrigate three to five acres. Mr. Hanscom's land is so situated that, with sufficient water, he could easily irrigate 50 to 60 acres. The soil is somewhat sandy and of a black color, and the land stands back from the river.

There is no reservoir connected with this plant If added, the same amount of water would do from four to ten times more duty, and thus not far from 10 acres should be successfully and profitably cultivated.

The result of this windmill irrigation plant has been so favorable that a number of Mr. Hanscom's neighbors will adopt the some plan next year.

This system of irrigation of small lots of land, say 10 to 12 acres, per mill, can be made to pay a large profit in North Dakota.

During the last season large inquiries have been made of this department in regard to this irrigation system, and information duly given.

WINDMILL IRRIGATION.

Hon. W. W. Barrett, Commissioner of Irrigation and Forestry, favors irrigation by means of windmills and in his annual report will present considerable data bearing on this subject. It is a question whether irrigation in this manner is practical on a large scale, but where the area to be watered is limited it has proved very successful. As an illustration, C. M. Fisher, of this city, watered his lawn and a small garden this summer by means of a windmill and the result was a surprise even to those who have claimed the most for the fertility of North Dakota soil. The lawn especially showed the beneficial effects of the irrigation. It was sown to grass in the fall of '93 and, while it usually takes two or three seasons for seed of this kind to "catch" and get a good start, Mr. Fisher had by long odds the finest lawn in the city last summer. The same was true of trees which he planted last spring. They did remarkably well and were apparently much more thrifty than trees that were not watered. The lawn and trees retained the greenness and freshness of early spring until late in the autumn.—*Devils Lake Inter-Ocean of November 30, 1894.*

WINDMILL DATA.

In order to assist those who desire information in regard to the capacity of different sized windmills, etc., I take the liberty to take a few extracts from the valuable work issued by the American Well Works, ~~of Aurora,~~ Ill.

For the purpose of imparting information in regular order, we now call attention to ~~the~~ smallest mill:

Eight and one-half feet in diameter, is constructed for light work on shallow wells ranging from 20 to 40 feet in depth, and will supply water for 75 head of stock.

Ten foot mill, is generally used for farm pumping and will furnish water for 300 head of stock from wells of 75 feet depth, and will pump from a depth of 200 feet. The quantity of water pumped, however, decreases as the depth of the well increases, and it is not profitable to use this size on wells over 125 feet in depth.

Twelve foot, is heavy and durable, with one-half more power than the 10-foot mill, and is used for the same purposes where more water is needed, or where the wells are over 125 feet in depth. This mill will supply 4,000 gallons of water per day on an average from a 75-foot well, and 2,600 gallons from a 150-foot well.

Fourteen-foot mill, has twice the power of a 12-foot, and is especially adapted for garden irrigation, pasture drainage, and general use about large farm buildings, and where wells are 200 to 300 feet in depth, or the water is to be forced a considerable distance.

For the benefit of parties desiring information in regard to pumps, we will say that for the first four sizes of mills, single acting pumps are generally used, their sizes of cylinder varying according to the depth of the well as follows: Twenty-foot well, 3½ to 4 inch cylinder, 12 inches long; 40 foot well, 3 by 16 inch cylinder; 50 foot well, 3 by 16 inch cylinder; 65 foot well, 2¾ inch cylinder; 75 foot well, 2¾ inch cylinder. Wells over 100 feet in depth, two and one-half inch cylinder. We recommend one and one-quarter inch pipe in shallow wells. Water cannot be sucked over 28 feet, and must be lifted or forced the balance of distance, the resistance being the same in lifting or forcing. Horizontal distances consume only the power required to overcome the friction of the water in passing through the pipe. If the well is deep use a tube well pump, as you can repair the pump without removing from the well, as the valves can be drawn up inside the pipe, and without calling a mechanic.

PRESSURE OF THE WIND.

The following table shows the pressure of the wind at different velocities:

Description of Wind.	Velocity.		Pressure per Square Foot in Pounds.
	Miles per Hour.	Feet per Min.	
Hardly observable........	1	88	.005, or about 1-12 of an oz.
Just preceptible..........	2	176	.02, " ⅓ "
	3	264	.045, " ¾ "
Light breeze..................	4	352	.08, " 1⅓ "
Gentle, pleasant wind......	5	440	.125, " 2 ounces.
Fresh breeze	10	880	.5, " 8 "
Brisk blow....................	15	1,320	1.125, " 1 lb. 2 oz.
Strong wind	20	1,760	2.
Very strong wind	25	2,200	3.125
High wind..................	30	2,640	4.5
	35	3,080	6.125
Very high wind	40	3,520	8.
Gale..............................	50	4,400	12.5
Violent gale................	60	5,280	18.
Hurricane	80	7,040	32.
Tornado	100	8,800	50.

From the above table it will be seen that with a velocity of four or five miles per hour, the pressure is less than two ounces per square foot of wind surface, and that its effective force depends entirely on the velocity.

CAPACITY OF PUMPS.

Table showing the number of gallons of water discharged per minute by a single acting pump, of a given diameter and stroke, at 20 strokes per minute.

Diameter of Pump Cylinder.	Length of Stroke of Pump in Inches.										
	4	5	6	7	8	9	10	12	14	16	18
2 inches.....	1	1¼	1¾	2	2	2½	2¾	3¼	3¾	4¼	4¾
2½ inches.....	1⅜	2	2¼	2¾	3¼	3¾	4¼	5	5	6¾	7¾
3 inches.....	2¼	3	3½	4¼	4¾	5½	6	7¼	8½	9¾	11
3½ inches.....	3¼	4	5	5¾	6½	7¼	8¼	10	11¾	12¼	15
4 inches.....	4¼	5¼	6½	7½	8¾	9¾	10¾	13	15	17¼	19½
4½ inches.....	5½	6¼	8¼	9½	11	12¼	13¾	16½	19¼	22	24¾
5 inches.....	6¾	8½	10	11¾	13½	15¼	17	20¼	23¾	27	30½
6 inches.....	9¾	12	14½	17	19½	22	24¼	29¼	34	39	44
8 inches.....	17¼	21¾	26	30¼	34¾	39	43½	52	60¾	69½	78¼
10 inches....	27	34	40¾	47½	54¼	61	68	81½	85	108¾	122¼

PUMPING CAPACITY OF THE "ADVANCE" WIND ENGINE IN GALLONS.

In the table below will be found the amount of water our mills will pump in good strong winds, and when attached to suitable pumps located directly over the well.

Diameter of Windmill Wheel.	25 Feet Elevation.			50 Feet Elevation.			100 Feet Elevation.			150 Feet Elevation.		
	Diameter of Pump.	Size of Pipe.	Gals. per Hour	Diameter of Pump.	Size of Pipe.	Gals. per Hour	Diameter of Pump.	Size of Pipe.	Gals. per Hour	Diameter of Pump.	Size of Pipe.	Gals. per Hour
8½ ft...	3¼ S A	1¼	800	2¾ S A	1¼	200	....	....	....	....	....	....
10 feet..	3½ S A	1½	575	3 S A	1¼	375	2½ S A	1¼	250	2¼ S A	1¼	150
12 feet..	4 S A	2½	960	3½ S A	1½	650	2¾ S A	1¼	400	2½ S A	1½	300
13 feet..	5½ S A	2	1,200	4 S A	1½	900	3 S A	1½	550	2¾ S A	1½	400
14 feet..	3 x 8 D A	1½	1,800	2½x6 D A	1½	1,100	2½x 6 D A	1½	800	1¾ D A	1½	500
16 feet..	4 x10 D A	2	2,100	3 x10 D A	2	1,700	3 x 8 D A	2	1,000	2½ D A	2	675
18 feet..	4 x12 D A	2½	4,000	4 x 8 D A	2	2,800	3 x10 D A	2	1.700	3 x 8 D A	2	900
20 feet..	5 x12 D A	2½	6,500	4 x12 D A	2½	4,000	4 x 8 D A	2	2,200	3 x10 D A	2½	1.400
25 feet..	6 x12 D A	3	8,000	5 x12 D A	2½	6,000	4 x12 D A	2½	4,000	3 x12 D A	2½	2,000

"S. A."—Single Acting Pump. "D. A."—Double Acting Pump.

HISTORICAL.—OLD QUESTIONS HAVE BECOME NEW.

Irrigation, forestry and meteorology, as well as agriculture are questions that have occupied human attention from the remotest time. The application of water to promote the growth of grain, fruit and other forms of vegetation can be traced back to the earliest historical records. The Chinese have carried the matter of irrigation to a very high degree of perfection, the commencement, according to their history, being in the comparative infancy or early periods of this ancient race. General Tcheng Ki Tong, the eminent Chinese writer, says "The efforts of our ancestors to subject the waters to their use dates back from enormous antiquity. I have documents to show how this was done forty centuries (4,000 years) ago." And it is well known that the irrigation in Egypt has been carried on with certainty and profit for many long centuries. The Peruvians irrigated their land extensively, and with good success, many years before their country was invaded by the Spanish conquerors. And in the southwest part of our country along the foot hills of the mountains, extensive ditches in good state of preservation are to be found this day wherein waters were conveyed to irrigate the lands below. And the protection of forests and the cultivation and love of trees have been woven into the annals of nearly all the nations and tribes of the globe, dating even from the time when those civilizations became tillers of the ground. And the ancient monuments and history prove that meteorology or meteorological observations were commenced when the race had made but little progress in the order of development. But it has remained for the latter years to bring these problems before the world in a systematic and scientific manner for the practical use of mankind. The discussions and analyses of these momentous questions have been great, earnest and thorough in our own country. But strange as it may appear, our nation was more than a century old before these things were embodied in proper form. In March or the early part of 1889, as the fruit of the long and intelligent agitation, there was created by an act of Congress the Department of Agriculture and those great factors, irrigation, forestry and meteorology, were merged into the new division. These have become with agriculture proper the leading fundamental parts of this the great indispensable branch ef the national government. To secure the proper administration and development of those branches or divisions, all subject to the jurisdiction of the Secretary of Agriculture, the government has secured the highest order of talent and scientific attainment, and the results, considering the limitation of appropriations and facilities, have thus far been most encouraging.

OFFICERS AT THE HEAD OF THE ECONOMIC DEPARTMENTS.

I cannot now give the name of the present incumbent, but for many years Major John W. Powell was the director of the United States Geological Survey. This officer in the prosecution of his work has much to with the question of irrigation in that it is his duty to select and locate the great reservoirs of water built by the general government. Each year the United States Congress appropriates a very large amount of money to carry on this work, and the appropriations for reservoirs to the present date number millions of dollars. Hon. Charles Irish, of Reno, Nevada, is Chief of Bureau of Irrigation Inquiry. This office is one of great usefulness, as it has in charge all questions and statistical facts relating to irrigation in the United States. The first chief of this bureau was Col. Richard J. Hinton, who was in office when the United States irrigation and underflow investigation was instituted in the semi-arid regions of the West in 1891. This was the most beneficial investigation ever instituted in the world in the interest of irrigation, as the facts and data gleaned were immense and of paramount importance, as any one may learn by securing through members of Congress the "Final Report (1892) of the Irrigation and Underflow Investigation." This investigation was extensive and thorough and cost the government $70,000.

Prof. B. E. Fernow is Chief of the Forestry Division. The office is one of very great importance as it embodies all the momentous questions relating to forestry, which industry in the United States yields but little less, measured in dollars and cents, than the productions of agricultural pursuits. The facts and truths presented in the reports and press articles of this ripe scholar and thinker are of priceless value. Any one can secure his reports free of charge by addressing him at Washington, D. C.

Prof. Mark W. Harrington is Chief of the National Weather Bureau. But few can question the great advantages and necessity of this, the division of meteorology. Our nation is fortunate in that Prof. Harrington, well schooled and practical, is giving a high status to the office. The National government is liberal in its appropriations. From 1872 to 1892 inclusive the amount appropriated was $6,558,802.03. This does not include salaries of office force and observers.

AN ERRONEOUS VIEW OF ARTESIAN WATERS.

Some persons entertain the idea that artesian waters are injurious to vegetation. When this question is examined in a thorough and considerate manner, it will be discovered that such an idea is erroneous in the extreme, and that on the contrary these waters contain the very elements necessary for the growth and maturity of grain, fruit, grasses and vegetables and all that is requisite is to understand how to apply the same wisely and properly in order to obtain the favorable results which must, as a necessary sequence, accrue from their proper application.

THE EXCEPTION, AND NOT THE RULE.

This erroneous idea arises from this fact—some of our artesian waters are so impregnated with certain kinds of elements that if applied immediately, and without any preparation, as they came from the ground, then in that case they do injure vegetation. But this is the exception and not the rule, as most of the artesian waters of North and South Dakota can be applied to vegetation immediately after being brought up from the earth, and the effect will, and is, most beneficial to all cultural productions.

EVERY DROP OF ARTESIAN WATER CAN BE MADE TO PROMOTE THE GROWTH AND MATURITY OF VEGETATION.

By intelligent and considerate manipulation and proper application, every drop of the artesian waters of North Dakota, and the entire world, can be made to work most advantageously and profitably in all manner of agricultural and horticultural pursuits. The simple law or rule of action is only this: put the waters into proper condition for the end in view. Practical experience or scientific instruction will make known what steps must be taken to perfect the needful condition. In ninety-nine cases out of a hundred all that is necessary is to impound the water in a reservoir and retain it there a sufficient time before using, for it to be chemically changed, by exposure to the air and sunlight, which will neutralize and change some of its unfavorable qualities. Thus the air and light and heat will prepare and adopt the waters for plant development.

A PROPER CHEMICAL CONDITION TO BE OBTAINED.

A chemical change, fitting the waters for vegetation, can be produced by use of metal wheels operating or stirring the fluid. Then, too, the desired condition can be attained by mixing certain soils or earths with the waters, or such soils will become favorable agencies to that end.

When I was a boy the art of applying manure for the production of large crops, especially that of corn, down in the state of Maine, was a pleasant study for me, as well as all "the boys" of the old homestead, who were all students of "the book of nature." I discovered that certain manures were so charged with "strong elements" of plant food, that if the corn was placed directly upon the same, where previously placed in the furrow for the corn hill, the corn lost its germinating qualities and would soon die. It would not even sprout.

AN EARLY LESSON IN NATURAL CHEMISTRY.

Now if I had viewed this phenomenon in the same light as our artesian waters are seen by some in the West, I would have said, "It is no use; the stuff is unfit to use. It kills all the corn placed upon its destructive elements." But being taught a little practical common sense by my intelligent father, I manipulated the manure, mixing it with the soil, thus subduing and neutralizing its qualities. And thus prepared, the kernels of corn, sound and of good quality, would be sure to germinate, grow dark and rank, and yield great and profitable crops. This experience suggests the necessity of the proper manipulation of the strongly impregnated artesian waters, which if intelligently done, will cause our western plains tô yield largest and surest, and most profitable crops. Let it be tried for our material good.

But the objector naturally deserves something more than one man's opinion upon this important question. That is right. The evidences are overwhelming in proof that artesian waters, intelligently and judiciously applied, do not injure but rather benefit vegetation, and that, too, to a high degree. I have, however, but limited space in which to present the testimony, but will call a few witnesses.

ARTESIAN WATERS NOT INJURIOUS BUT BENEFICIAL TO VEGETATION.

ABERDEEN, S. D., May 25, 1891.

W. W. BARRETT, Lakota, N. D.

DEAR SIR:—In reply to the question of whether or not the water from artesian wells in the Dakotas is injurious or destructive to grain, vegetation, trees, etc., I will say that during the past year I have had occasion to visit nearly all the localities in the Dakotas where artesian waters have been found, and with the exception of one or two instances, I have not heard that artesian water injures vegetation when properly applied—not even the most delicate house plants. At Devils Lake and Jamestown I have heard that artesian water has been known to kill house plants; but outdoor plants, trees, etc., are, on the contrary, benefited by a proper application of artesian water at times when there is a lack of moisture in the ground. The excessive use of artesian water will injure and sometimes kill vegetation, and even trees, just as the purest water will do.

Amateurs in the art of irrigation are very apt to use too much water, and the fault is more likely to occur from the quantity rather than the quality that is used. I think artesian water for irrigation purposes should be held in reservoirs as long as practicable before being used; the exposure to the air and sunlight will neutralize and change some of its objectionable qualities, at the same time the air, light and heat are preparing and adapting it for plant development.

The benefits derived from irrigation are so well established that I need not refer to that part of the subject. I do not think there are any grounds for fearing the water obtained from wells in the James river basin will not be suitable for agricultural purposes. The great concern of the people I should think would be how to solve the problem for getting water for irrigation when they need it.

Any letters addressed to me at Huron will be promptly forwarded.

E. S. NETTLETON,
Chief Engineer of the Irrigation and Underflow Investigation.

Prof. Lewis McLouth, president of the South Dakota Agricultural College, a gentleman of the highest authority upon such matters, makes this statement in regard to artesian waters of South Dakota, which are similar to those of North Dakota: "There are no 'alkaline' ingredients in these waters. Many samples of water from all parts of South Dakota have been tested by the chemist of the experiment station at Brookings, and not one of them has shown any alkaline reaction. The entire amount of saline—not alkaline—matter in these waters in South Dakota does not, on an average, exceed one-fifth per cent. after subtracting the inert substance—sand, clay, limestone and iron ores. These ingredients are salts of lime, magnesia, potash and soda. Every ingredient of these artesian well salts enter into the tissues of plants, and is a necessary food for them." Thus it appears instead of artesian waters being injurious, they contain the very elements indispensable to plant life.

Fred F. B. Coffin, the first state engineer of irrigation of South Dakota, in his able report of Dec. 1, 1890, says: "When we examine the analysis of artesian waters we fail to find anything injurious to vegetation. Whenever artesian water has been applied to vegetables or grain, the effect has been marked and satisfactory. And Mr. Coffin also states that artesian water applied to the soil before seeding commences, or after the grains have germinated, have uniformly proved most favorable, insuring good growth and quality of wheat and other grains.

THE STATE EXPERIMENTAL ARTESIAN WELL AT EDGELEY.

Our last legislative assembly appropriated $5,000 for the establishment of an experimental artesian well at Edgeley, but nothing has been accomplished in the matter, as will be learned by the following letter:

NORTH DAKOTA AGRICULTURAL COLLEGE.
J. B. POWER, President.

FARGO, N. D., Dec. 28, 1894.

Mr. W. W. Barrett, State Superintendent of Irrigation, etc.,
Church's Ferry, N. D.

DEAR SIR:—In reply to yours of the 23d, asking the present status of the artesian well at Edgeley, will state that nothing has been done. None of the bids received were in accordance with the requirements of the board, so it was decided to let the matter stand over for such action as the next legislature might see fit to take.

Yours respectfully,

J. B. POWER.

ART OF ENGINEERING.

"The art of the engineer is to control and adapt the forces of nature, in a feeble way, to the uses of man. He is the only one in the body politic of society who has practical experience in dealing with those forces in that way. He will tell you that the handling of water is the most difficult problem of his art.

I need not expand upon the application of all this to forestry. This art has for its object the preservation of the old, the creation of the new. Wherever it goes, water is a vital factor.

A COLOSSAL EXAMPLE.

"In the interests of the navigation of the Mississippi river, the United States has established a collosal example in the conservation of water. It is rather an obvious proposition that more water will improve the navigable capacity of any river. And the greater the navigable capacity of any waterway, the greater its commercial value. But it is not generally known that this latter value increases very much faster than the former.

CAPACITY OF THE MISSISSIPPI.

"It takes, however, a great deal of water to help a river. The Mississippi, near St. Paul, requires over 3,000 cubic feet per second before it can accommodate boats drawing three feet of water. This means a little less than 2,000,000,000 gallons per day. The reservoirs are designed to furnish about that quantity of water during the period when the water in the river is ordinarily low. This period varies from 60 to 90 days, and hence the whole quantity that may be called for in a season is about 180,000,000,000 gallons. Their maximum capacity is about 675,000,000,000 gallons.

PRESENT RESERVOIRS.

Five reservoirs are completed and in operation:

LAKE WINNIBIGOSHISH.

Watershed, 1,422 square miles.
Water surface, 110,206 acres.
Storage capacity, 344.000,000,000 gallons.

LEECH LAKE.

Watershed, 1,225 square miles.
Water surface, 110,632 acres.
Storage capacity, 225,000,000,000 gallons.

POKEGAMA.

Watershed, 630 square miles.
Storage capacity, 35,000,000,000 gallons.

PINE RIVER.

Watershed, 602 square miles:
Water surface, 15,206 acres.
Storage capacity, 56,000,000,000 gallons.

SANDY LAKE (Nearly completed).

Watershed, 384 square miles.
Water surface, 7,522 acres.
Storage capacity, 15,600,000,000 gallons."

—Maj. W. A. James, of Engineer Corps, U. S., in charge of the reservoirs at headwaters of the Mississippi.

DEVILS LAKE SHOULD BE CONVERTED INTO A NATIONAL RESERVOIR.

A movement has been on foot for some time to convert Devils lake into a great national reservoir, taking the water from the Missouri river, and letting it out as it may be needed, to supply

the Cheyenne and the Red rivers, making the latter navigable, which is a most desirable consumation.

AN ARTESIAN WELL AT BOTTINEAU.

This season (1894) Thomas Gardner, of Bottineau village, bored an 18-inch well at that point, sinking the hole 62 feet. He struck a reservoir, or flow of water, that rose 60 feet, and it has remained stationary at that height ever since. And it is pleasant to remember the water is most healthy, pure and soft.

This constitutes a negative artesian well, and its favorable development is a confirmation of my long cherished conviction, that large quantities of water exist in the vicinity of Bottineau, that with a small outlay will give a large supply of water, which, lifted by windmill power, or by other means, can be easily applied on lands in that vicinity, whereby remunerative crops will be assured.

ALL ADVOCATE THE SAME REMEDIES.

Whenever the drouth comes to scourge a state or nation, especially in these last days of thought and practical action, the writers, as is their duty, seek to point out a remedy for the prevention of such unfavorable climatic conditions. And in that direction, what do we discover? Why, a universal concurrence of opinion, to-wit: That the proper use of water, or irrigation, conjoined to tree culture and the conservation of the forests will largely, if not wholly, remedy the evil.

Thus speaks the New York Tribune in regard to the drouth, which prevailed both east and west this season (1894):

"These evils are, we confidently believe, largely to be corrected by irrigation, conjoined with tree planting and forest conservation; and this belief is founded not on theory alone, but on actual achievements. Vast areas in the West, once sterile as the Sahara, are today rich and fruitful. The loss suffered by the average farmer in this one season amounts to as much as the cost would be of equipping his farm with appliances sufficient to make him practically independent of the weather."

OBJECTIONS TO IRRIGATION.

Opposition to irrigation appears in many ways. I will present a few of the "arguments" of the opposers.

Objector.—"Irrigation is an innovation, a new-fangled idea; the old methods of our fathers are always the sure, safe way. I utterly condemn the whole scheme."

Friend of the Economic Development.—"It is not an innovation. It has been employed in China with the most gratifying success for over four thousand (4,000) years, and today that land is one vast irrigation garden, supporting an immense population from the fruit of the system."

The soils of Egypt were irrigated, and thereby made to fill the granaries of that country many centuries ago. And back through the ages past the great semi-civilized race of the western continent, the Peruvians, watered their land artificially for the increasement of crop, and the remains of their irrigation ditches are to be seen in that historic land at this time. And the prehistoric people of North America constructed their irrigation ditches in the southwest part of the now United States, and cultivated their crops with the waters impounded therein. Those self same ditches are plainly to be seen at this day. When at the World's Fair in 1893, I visited the Cliff Dwellers' cave (these people had their cliff dwellings in the western part of Colorado) and there I saw the work and remains of those people who are supposed to be some of those ancient irrigators, as they dwelt near those old ditches, and were an ancient people and far advanced in the arts and industries of life. Their tools, their ladders, their saddles, their tanning, their looms, their weaving, their cloth (very much like and equal to our best woven cotton grain sacks) their embalming and their mummies constituted a large museum. Nor was this all. There I saw parts of the *identical grain* of these wonderful people, consisting of *corn, beans, pumpkin seeds, parts of pumpkins, etc.*, all of which may have been raised from the irrigated lands of that ancient prehistoric race.

Irrigation has run through the entire history of the human race. Even in the garden of Eden, the Bible tells, the river was made to water the land.

So, friend Objector, upon investigation, you will discover irrigation is no new idea, but a very old one, endowed with new interest because of the practical advantages revealed through the teachings of science and the advanced engineering skill of the present generation.

Objector.—"Well, the idea may be old and great enough, but it is a discredit to any state to have it noised abroad through the press that such things are carried on in such territory."

Friend.—"Now, sir, irrigation is *not a necessity* in North Dakota but, as in all states and nations, an inexpressible benefit, if properly conducted, to our wise people. Can it be discreditable for us to use fertilizers or manures to increase our crops? Is it discreditable to use electricity, as being done in some parts of the world, to accomplish the same end? Is it discreditable to build hot houses whereby, by means of sunlight and heat, all manner of vegetables may be rapidly, surely and profitably produced? Is it discreditable to employ any element of nature to promote the quantity and quality of grain, fruit and vegetables? Was it a discredit to the ancient nations who employed various systems of irrigation for the enhancement of their crops? Is it a disgrace to India, China, Egypt, Australia, Europe, the southern and western states of our union and Mexico also, to make use of irrigation in such a manner as to produce phenomenal growths of the cereals and fruits by this safe, sure and wise method of cultivation? Was it a disgrace for California and other western states to exhibit, in the most attractive manner, at the great World's Columbian Fair, the grains and fruit produced *wholly* by means of water applied by thoughtful skill to the soils of those states? Was it a disgrace for New Mexico to place large placards over its magnificent exhibit in the Agricultural building, stating "these products were raised by means of irrigation"? Nay, sir, it is not discreditable to any state to raise large and remunerative crops by the artificial application of moisture.

If these things are discreditable to any state or nation, why has the United States government and numerous states, associations and private individuals expended millions and millions of dollars in the investigation, development and practical application of irrigation in the union, particularly in the West? Surely the United States and the various states, saying nothing about individual action, should not be engaged like other nations of the earth in things discreditable. If these things are discreditable, why has the national government given North Dakota, and the same to each of 12 other western states, 1,000,000 acres of land for irrigation purposes—1,000,000 of acres of land for discreditable purposes?"

Objector.—"Well, sir, I have never thought of this subject in this light. You put the thing, however, in too strong language."

Friend.—"No, sir; no lip, no tongue, no pen or type can portray the credit, the honor, the glory, and the practical advantages to the state, nation and the people that must accrue from the scientific, intelligent and common sense use of water in the way of different irrigation systems for the certainty and abundance of crops in dry or wet seasons."

Objector.—"You may speak truthfully, but it is very objectionable because it takes vast amounts of capital to develop and carry on irrigation systems."

Friend.—"Well, yes; that is a serious, most palpable, overwhelming and almost insurmountable objection! I hardly know how to meet such an all-serious and all-wise 'argument!' Of course, capital should be retained in the vaults and banks to be let out to the drouth-stricken, impoverished and suffering 'sons of toil' at 10, 12, 60 per cent a year, so the poor unfortunate may 'live at a poor living rate' in the garden lands of the West, where all that is needful for the enrichment of the people is the proper application of moisture to the crops in order to insure large and bountiful yields and large profits.

But how much capital does it take to dig out a well 35 to 40 feet deep, or dam up a creek or lake, that water may be obtained to run in ditches over the land for cultural pursuits? But in large enterprises it takes much capital. But is that a serious objection? It takes capital to build steamships, but they pay; to establish telegraphs and telephones, but they pay; to build and operate railroads, but they pay. But under right conditions $1,000,000, properly employed and judiciously managed, in an irrigation enterprise in any state or nation in the world, in dry or wet seasons, but particularly in dry seasons, will pay on an average from season to season from 50 to 1,000 per cent. on the capital and labor bestowed upon the undertaking.

Then, sir, I can see no serious objection to the use of moisture in the form of irrigation for the highest attainment and most profitable results in agricultural and horticultural pursuits.

Surely it is creditable, discreet and wise to use the Providential bestowments of the elements of nature, particularly that of moisture, for the glorification of the State and the enrichment, comfort and happiness of the people."

WILL IRRIGATION PAY?

Guided by the light of reason and the laws of plant life, I would answer in the affirmative. All forms of vegetation—grain, fruit, grass and vegetables, must have a supply of moisture, otherwise they will of a certainty die. And irrigation, or irramot, is but the artificial application of moisture for the growth and maturity of these forms of vegetation. If sufficient moisture is wholly lacking or insufficient in volume for the fullest and best crops.

If moisture is wholly lacking or insufficient in volume for the largest yield and best quality of crops it will pay to irrigate, provided the income from the productions will give a good margin over and above the money and labor invested.

But the North Dakotan farmer, like all other practical men, cares little for theory "or due process of reason," but wants to know "what are the facts." Well, the *facts are, irrigation will pay!* In every state and nation of the globe in ancient and in modern times under right conditions, wise tillage and proper management, the general result has been large yields of cultural productions with good round profit on the capital and labor employed in the undertaking. The immense fruit and grain crops of California and other western states, the vast rice crops of the South, and the bountiful cranberry harvests of the North and the enrichment of the persons engaged in the enterprises is good evidence that irrigation pays.

But you want the direct testimony upon this point, and hence I present so much as space will allow:

The Consolidated Land and Irrigation company is located at Huron, S. D., and the manager of the concern, R. O. Richard, stated to the writer under date of Nov. 16 1891—the yield of wheat was 53.20 bushels to the acre, being fifteen to twenty-five bushels per acre more than the yield on adjoining unirrigated wheat. This gentleman estimated that his land, including the well, reservoir, ditches, etc., cost $15.00 per acre, and wheat at 75c per bushel, the then price, gave a yield of $30.00 per acre, or double the original cost of the land and improvements.

IRRIGATION IN THE JAMES RIVER VALLEY.

The most productive agricultural regions in the world have been irrigated regions. There is hardly any limit to the productiveness of soil which, by artificial means, can be supplied with just the right quantity of water at just the right times. Under the valley of the James river in South Dakota, and covering an area of 8,000 square miles, there is an inexhaustible supply of water, coming from the mountains west, which can be brought to the surface in living streams by boring a well from 500 to 1,200 feet deep on any quarter section. Hundreds of these wells have been bored, and within the area named there has never been a failure to get water in quantities varying from 20 to 60 barrels per minute and issuing with a force varying from a pressure of 50 to 150 pounds upon the square inch. The smallest of these quantities is enough to afford ample irrigation for a square mile of land during our dryest years.

These waters are so nearly free from mineral matters, or the mineral matters in them are so harmless or inert that there is no possible danger of poisoning the soil by their plentiful use for irrigation. In fact the mineral ingredients in these waters are very largely the same as found in our most fertile prairie soil.

A square mile of land can be provided with a well and with reservoirs and ditches for irrigation at no greater expense than has been lavished upon many eastern farms for necessary tile draining.

During the past two years a great many practical trials have been made, some by the Agricultural Experiment Station connected with the State Agricultural College, and all the evidence goes to show that irrigation is easily practicable by means of artesian wells in the valley of the James river. Forty to 50 bushels of wheat per acre obtained, even under imperfect irrigation, side by side with unirrigated fields that yield only from five to 12 bushels.

I believe from a two or three years' study of the matter, that within ten years the whole of this great valley of the James river will have its productiveness quadrupled by the aid of irrigation from the artesian wells.—*Lewis McLouth, President South Dakota Agricultural College and Experiment Station, Brookings, S. D.*

PROFITS OF IRRIGATION.

The first question that the practical man asks in regard to any business enterprise is, "Will it pay? Will the returns justify the expenditure?"

That is the practical problem that now confronts the Dakota farmer and investor. If answered in the affirmative, then we should bestir ourselves to find out the most economic plan to make the application. If answered in the negative, then we should stop all agitation of this question and apply ourselves to find out some other mode of cultivation by which we can force the earth to return an adequate yield for the expenditure of our money and labor.

There is no other proof so conclusive and so unanswerable as the facts pertaining to what has been done.

In searching for the source of the power and opulence of the kingdoms of ancient times, we are irresistably led to irrigation as the basis cause. Had it not been for the irrigated lands along the Euphrates, the Tigris and the other rivers and streams of the Medo-Persian empire, the dense population of that country could not have been sustained, and hence its power could not have existed.

Had it not been for irrigation the 700 years of occupancy of Spain by the Moors would not have been attended by that splendor and opulence that has ever since been one of the wonders of the world.

All ancient history is fraught with proof that the older civilizations were often saved from destruction by receiving timely aid by products from irrigated lands, but history records no instance where a country has suffered drought or famine where water could be had and irrigation was systematically and thoroughly applied. Neither does it record a single instance where it has been abandoned because it did not pay. Neither does it record a single instance where the products raised by intelligent irrigation could not compete in the general market with products raised by rainfall. But the evidence is abundant and without exception that irrigated products command the market. They are superior in both quality und quantity, and command more remunerative prices. There is no arguing these propositions because there is no evidence on but one side.

Let us see what irrigation has done in our own country, and under our own eyes. The following statements are taken from the report of the special committee of the United States Senate, on the irrigation and reclamation of arid lands, that visited this State last August (1891):

William Courtney, of Miles City, stated he had lived in Montana 23 years; that he came from New York; that the irrigated lands in Montana would yield five times as much on the average as farms in New York state.

S. Gordon had lived in Minnesota where they raised 10 to 12 bushels of wheat to the acre. By irrigation in Montana they raised 50 bushels to the acre.

H. H. Rowley, of Billings, Montana, states that they raise from six to nine tons of alfalfa to the acre. They cut two to three times.

T. H. Conrad, of Billings, states that the farmers there raise from 40 to 50 bushels of wheat.

T. J. Luce, of North, says that he has raised 80 bushels of oats to the acre, and in that valley they raise from 40 to 70 bushels of wheat. That he has been farming there 11 years and the land produces now better than when he commenced.

W. W. Alderson, of Bozeman, states that oats yield from 50 to 100 bushels to the acre. When well cultivated and properly irrigated it will average 75 bushels to the acre. Wheat about 40 bushels to the acre. When asked how much more it cost to farm by irrigation than by rainfall, stated that after he had the ditches constructed it cost him about $1 per acre more. That when the ditches were all fixed and prepared, it was comparatively a small job.

When it is considered that through a scarcity of rainfall at the proper time the crop is often an entire failure, the benefits of irrigation become more apparent. The rain may fall at a time when it would destroy rather than benefit the crop. Hence a crop depending on rain is an uncertainty. But in localities of light rains where a system of irrigation has been adopted, there alone, crops are a certainty, and the profits of a farmer are as sure as the successful manufacturer, merchant or miner. In short, irrigation in the Dakotas will make farming a profitable business.—*Ex-State Engineer of Irrigation of South Dakota, Major Fred B. F. Coffin.*

IMPORTANT TESTIMONY.

Col. E. S. Nettleton, the chief engineer of the Underflow and Artesian Investigation, instituted by the national government in 1891, in response to the question "Does irrigation pay?" makes this reply:

I will say *there is no doubt about* the question "*Will irrigation pay?*" The success that has attended irrigation experiments has amply proved that irrigation will pay in the Dakotas, even in seasons where the rainfall is quite sufficient for a fair average crop. The people of Dakota can hardly *over estimate* the value of their artesian supply. It is a great thing in agricultural pursuits to be able to control the requisite amount of moisture, especially in a country having a soil that responds so bountifully as that of the Dakotas. After the people of Dakota have their irrigation works once well established they will find that they have a new responsibility on their hands. Heat, light, and moisture are essential elements to the full developments of agricultural products; nature provides for the first two, and in irrigation man controls the latter. Heat and light in the Dakotas are supplied in profusion during the cropping season, so when man assumes control of the water, he will, as a rule, be accountable for the crop. In common with nearly all plains country, Dakota lacks the ordinary conditions necessary for water power for manufacturing purposes, but provision has been made to supply this need by the wonderful power of the artesian flow. It is entirely practicable to harness and put this power to a beneficial use, and, after serving this purpose, it is still ready to serve the land.

Very truly yours,
E. S. NETTLETON,
Chief Engineer.

THE DUTY OF WATER.

It is estimated that in New Mexico it takes one cubic foot of water running night and day to irrigate 160 acres. In Colorado the flow of one cubic foot per second throughout the irrigation season is sufficient for about 100 acres, and the same amount of flow from the Dakota artesian wells, in experienced hands, will irrigate successfully nearly 200 acres.

SUCCESSFUL EXPERIMENTS MADE IN SOUTH DAKOTA.

One of the most important questions before the coming legislature will be regarding the question of sinking wells for irrigation and other purposes. That there will be a general inclination to reduce the expense of the State government to a minimum, there is no question, yet there is also a determination on the part of the taxpayers to secure such legislation as will insure a thorough and practical trial of the artesian well system, both by irrigation and surface, lake and stream supplies, so that the theory of attraction in this manner may be demonstrated throughout the artesian belt.

The third biennial report of the State Engineer of Irrigation is now in the hands of the printer, and from the proof sheets many questions of interest are deducted. Among the many reports of experiments of irrigation are the following: Loren A. Buswell, of Condee, Spink county, has this, his second year, tested a 10-acre tract, with the following results: Garden truck to the amount of over $1,500 has been sold, while the expense of distributing the water was but $75.

W. O. Bisserund, Cavour, Beadle county, irrigated 19 acres, for which he paid the township $1 per acre for the water. Result:

Wheat, 32 pushels per acre; oats, 50 bushels; onions, 250 bushels, and potatoes, uncultivated, 85 bushels.

Alonzo Melville, Huron: Wheat, 38 bushels; oats, 95 bushels; potatoes, 280 bushels; millet, 4 tons per acre. Mr. Melville will irrigate 60 acres next year, and claims that the extra crops each year would pay for the sinking of a well each year.

The above are only three of more than a score of testimonials published by Mr. Fassett. Mr. Fassett states that the expense of a three-inch well, which would naturally flow, say 900 gallons per minute, should cost not to exceed $1,700, and a four and one-half-inch well, at a cost of about $2,000, should irrigate from 640 to 1,000 acres.

One experiment shows that the flow taken direct from the well, 21 days' flow, 17½ days' labor, flooded 100 acres from 8 to 12 inches. This year there have been 15 wells sunk, under the law of 1889, and 18 under the law of 1893, while there have been scores of personal or individual wells sunk.

There is no question as to the future of South Dakota, provided a water supply can be obtained, and there is also no question but an abundance of water can be had over a part of the territory, provided means can be obtained to bring it to the surface.

There are many theories as to the best manner to secure such means, but the general impression is that it must be done in some manner by the state, and under state supervision. Take, for instance, the proposition to sink four wells in each township. These wells can be secured at a cost of $7,200 for the four and a half-inch in size. Six per cent. bonds could be floated at par, and the interest thereon would be less than $3.50 per quarter section. This water could, in most sections, be used for irrigating purposes, and it could all be run through ravines, creeks and streams into dams, small lakes and the like, and the amount of water on the surface would attract rainfall, evaporate in dews and kill all the hot winds. It would not only increase largely the yield of grain and grass, but it would also supply an abundance of water, which would make South Dakota the greatest stock growing state in the union.

This question the farmers have determined to make the one and all-absorbing one before the coming body of law makers.

Athol, S. D., December 18, 1894.

PROFITS OF IRRIGATION IN THE SANDS OF THE SAHARAEN DESERT. MILLIONS OF ACRES OF FORESTS THERE RAISED BY MEANS OF IRRIGATION.

Even beneath the sand and barren wastes of the Great Sahara desert there comes to light the wealth of a great artesian deposit. The work of reclamation has been carried on for years under the French ruling, the desert province of Algeria.

The area, officially given, of French Algeria, is 184,465 square miles, the outlying portion at 135,000 square miles. In this total of over 329,415, one-half belongs to the Sahara or desert. The European population in 1887 was about 250,000; the natives and naturalized were 3,328,524, making a total of 3,578,549. Artesian wells as a means of reclamation began to be systematically bored in 1857, the French engineer, M. Jus, having demonstrated in 1856 that the desert was endowed with large supplies of underground water. These wells range from 75 to 400 feet in depth, and the low pressure common to the majority of them forces the water over the small bored casings to a distance of about two feet above the ground. The waters are then collected in small ditches, which convey them to the vineyards, date trees and fields of durra, millet, wheat, etc., which comprise the chief products.

In all, about 12,000,000 acres have been reclaimed in this way. The government bores at least a tenth of the whole number. As an illustration of the reclamation brought about by this well irrigation, the following figures, from a report made in 1885, will be of value, but they relate solely to the cultivation of the grape for wine-making purposes. In the province of Algeria there are 60,322 acres; in Constantine, 25,051 acres; in Oran, 26,114. Under this species of cultivation, Algeria is becoming a great wine-growing country. It sent to France during eleven months of 1886, 10,513,966 gallons of wine; and of cider in the same year, 219,277,124 gallons were made. The date palm is the largest product of the oases proper. The total area under colonization or settled occupation in 1887 is given at 49,400,000 acres; under cultivation by irrigation in wheat, barley, tobacco, oats, vines, olives, dates, etc., at 17,031,133. The forest plantations cover 5,000,000 acres.

If 12,000,000 acres of the Saharaen desert can be successfully reclaimed, and be made to pay a profit on the money and labor invested, why cannot we of North Dakota, where we have the largest artesian basin in the world, do equally as well?

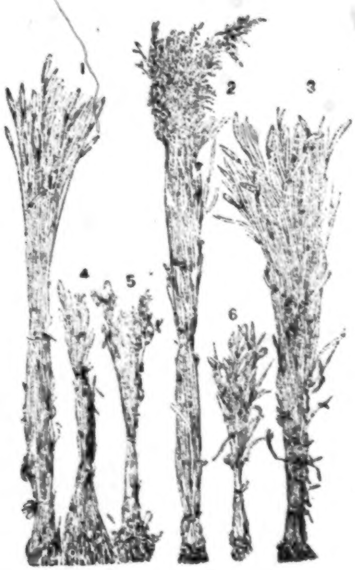
And if we would utilize our artesian waters, as they are doing in the greatest desert of the world, for the raising of trees in our garden lands, then instead of 5,000,000 acres, as the French have in those long barren wilds, our forests might be made to occupy one-third of the area of the State, which would produce conditions most favorable for profitable farming. Surely this Egyptian lesson is worthy of attention.

LARGER FOREST AREA.

I am such a strong believer in the good climatic effects of large forest areas dotted over our western droughty sections, that I would like to see our representatives in congress proceed with measures to have several 5,000 to 20,000-acre tracts planted to trees in each county between the one-hundredth meridian and the Rocky mountains. Ten to 20 per cent. of the lands thus kept in forests by the government would furnish much needed fuel and lumber to future generations and the remainder of the land would produce more values than the whole left as a stove top like plain on which clouds can not fall because dissipated by the heat. Give us more trees to help us raise more wheat and stock and to have a more pleasant country to live in.—*Prof. N. M. Hays.*

IRRIGATED AND NON-IRRIGATED GRAIN AND HAY.

The samples of grain and millet herewith illustrated are from a photograph, and represents the irrigated and non-irrigated, side by side. Nos. 1, 2 and 3, are the irrigated; and 4, 5 and 6, the non-irrigated.



1 and 4, Wheat; 2 and 5, Oats; 3 and 6, Millet.

[Plate kindly furnished by E. A. Webb, editor Farmer and Breeder, St. Paul, Minn.]

CORRELATION OF IRRIGATION, FORESTRY AND AGRICULTURE.

Agriculture is connected directly with and is inseparable from irrigation in its broad comprehensive sense, as indicated by the new word irramot. Indeed agriculture, the chief and most important of all human industries, would cease wholly and altogether in the absence of moisture, the basic principle of the science or art of irrigation, but the forests of the world are indespensibly necessary to keep in proper balance the elements of nature, without which agriculture would become enfeebled, unremunerative and finally inoperative, and man and animal life would cease to exist. Hence it can be seen irrigation, forestry and agriculture are all intimately correlated, and should be developed and placed in proper relationship one to the other for the most favorable results to accrue therefrom.

This interrelationship, the union of natural forces, the dependencies and beautiful law of natural operations, if traced to its final conclusions, would open up a new order of thought, and the discoveries made, would prove of great importance, for better ways of actions would be seen and made practical for the betterment of mankind.

An able writer pursuing this study, speaks of the connection of forestry with agriculture, thus: "In this new light, we behold he delicate correlation of agriculture with forestry What the intelligent farmer does with the green manure of leguminous plants whose nitrogenous properties they have extracted from the air, nature is constantly doing in her massive forests where the spoiler hath not trod. She manures the forest soil with green and ripened leaves; they form a perfect mulch that economizes the moisture which the trees must have; they oxidate and decay next to the surface soil, whence is evolved the needed nitrogen for plant growth. Thus the roots by a chemical art that we cannot fathom, take up the primates of the mineral kingdom and transform them into living tissue. If on this progressive line there is yet a deficiency of nitrogen for healthful assimilation, the lower forms of life, bacteria generated by these processes, build ganglio-batteries on the famishing roots, and the trees are re-invigorated for woody structure. This chemical operation, whereby pure oxygen is tendered us, prepares a soil for future agriculture, rich in nitrogenous and other necessary materials for crop growing. The forest is, therefore, the chief source of soil fertility, costing us nothing except care for the trees. In view of its inestimable value Humboldt exclaimed: "How foolishly man destroys the forest cover without any regard for consequences, for thereby they rob themselves of wood and water!"

FOR IRRIGATING LANDS.

Farmers who have suffered the effects of occasional drouths, and whose lands would be productive as any on earth, were they watered in a moderate degree, either naturally or artificially, will be interested in the work that is now going on, in regard to irrigation. The irrigation congress is now discussing the question of government aid in the reclaiming of lands which are semi-arid, and if this could be accomplished, thousands of acres of land in North Dakota could be made more productive, and homes pro-

vided for thousands of settlers. But Congress having ceded these lands to the states in which they are located, may not see the wisdom of further aiding in their development. And in this case, the question of rendering them fertile and productive will devolve upon the states alone.

The question of irrigation has not been sufficiently regarded by farmers, and in fact all residents of the West, who have experienced the disagreeable features of crop failure. In some parts of the State of North Dakota at present, private parties have gone into the cultivation of small tracts of land, with the aid of windmill or artesian water supply. To one who has not tested this means of supplying water to a field of moderate size, the results are almost incredible. The irrigation is not conducted on an extensive scale, as in totally arid districts. Enough water to relieve the parching effect of continued hot weather, is distributed over a field, after sundown, and is followed by a yield which surpasses expectation.

If a test could be made in this county, either by windmill supply or by a supply from a reservoir to be constructed on the bank of some one of the streams which flow through it, the result might simplify the farming question. It wouldn't be a bad idea for the farmers of the county, or of many of the counties of the State, to hold an irrigation congress of their own, and discuss ways and means. In Colorado, there are 12,000 miles of main irrigation canals, which have cost $50,000,000, and are today worth more than $100,000,000. In New Mexico, one company has a capacity of 6,311,000,000 cubic feet of water, covering 40,000 acres of land. An Idaho company irrigates 350,000 acres, and southern California exists by the facilities furnished agriculture by the irrigation companies. And it is estimated that there are 800,000,000 acres of land in this country, which, when irrigated, will be as productive as any acres on the face of the earth. Irrigation is a subject that all western farmers want to consider, and a result which all western people should strive to bring about—either through state, national or individual efforts.—*Bismarck Tribune, Sept. 7, 1894.*

MOUNTAIN RESERVOIRS.

"The Rockies constitute the great alembics of rain distillation from the beneficent heavens; and the native forests there further refine and adapt it to our needs. Shall these continental blessings be preserved or allowed to be ruined by our persistent lawless and extravagant methods of lumbering? Let our affirmation be one of action, else in a few years water supply is absolutely lost to the Great Plains. The low humidity, low pressure, high temperature and high rate of aerial motion over these plains, evolve an evaporative power too vast to calculate. As the Pacific winds, laden with moisture, climb the western slopes and cool down in the high altitudes, their humidity is strained out to return in rain upon that favored region, arraying it all in luxurious vegetation. But as these winds, now dry, slide rapidly down the hither sides fronting our tables and prairies, piling stratum upon stratum, they are gradually warmed by compression, amounting to six or seven degrees for each 1,000 feet, and leap out from the foot-hills much warmer than when they started. Though this high temperature increases the capacity of holding moisture, there are no means to regain what was lost on the mountain crests; for what have we on the eastern slopes but, comparatively, a sombre desolation and a wide stretch of aridity? Hence we are pelted with these simoons from the southwest and west with a dessicating power that is indescribable, acting in mid-summer upon our unprotected vegetation like waves of fire, lapping up the springs and streams as with demon tongues.

In vain our efforts to stay these annual scourges by culture of the prairie lands and leave forestry untouched and unbefriended. All this but augments our aggravation and disappointment. Farming, with neglect of forestry, but adds to our agricultural weariness and disappointment. The very voice of the Almighty speaks to us from out the drouth and the cyclone: "Bring forth fruits meet for repentance."

IRRIGATION HAS EXISTED FROM TIME IMMEMORIAL.

Did not the river of Eden wet the land for plant life?

It has been practiced in China for 4,000 years; in Egypt, 3,000 years. By it the Moors, during a period of 700 years, made Grenada the garden of the world. Ancient Mexico and Terean, when discovered by the Spaniards, had systems of irrigation more complete and systematic than any now on this continent. Ancient Peru also had vast systems of irrigation. And this is true of the prehistoric races of the United States, whose ditches are still in a good state of preservation in the West. Irrigation was conducted during long years on the lands bordering on the Euphrates and the Tigris, and other rivers and streams of the great Medi-Persian empire, and this system became the source, to a great extent, of the power and opulence of that great ancient kingdom.

THE INTEREST IN IRRIGATION IS UNABATED.

Loss of crops, caused by drouths, lack of moisture, hot winds, frosts, etc., is having a salutary effect, in that it is setting the impoverished to thinking how these destructive manifestations of the elements may be prevented. Thus the universal conclusion is the planting of trees and forests in large masses where needed, and the proper control and manipulation of water in form of irrigation for cultural purposes will produce the best conditions and will result, all other things being equal, in a great increase and certainty of crops and profits. Hence the interest taken in these correlated economic reforms.

From East, West, North and South comes inquiries as to the best methods of irrigation, and various systems, most of them of a practical nature, are being devised for this purpose.

It must be remembered that irrigation is adaptable and can be successfully conducted in all countries where water can be obtained in proper quantities from surface or underground sources. This applies to all parts of the world, whether the sections be "dry" or "wet." Lombardy has an annual rainfall of 36 inches, and yet for 700 years she has irrigated with good profit vast territories.

India has expended directly and indirectly at least $200,000,000 for irrigation purposes. The systems of canals constructed in that country are most extensive and stupendous—the greatest in the world. The Ganges canal is ten feet deep and one hundred and seventy-five (175) feet wide, and irrigates 1,500,000 acres of land, *and it pays.*

THE INTERNATIONAL CONGRESS OF THE WEST.

Throughout the entire West there is a predominating sentiment that is worthy of consideration. It is this: To inaugurate such comprehensive movements and systems as will make the common people realize sure and profitable crops, and find the most favorable conditions for the establishment of the ideal home. And the great thinkers and intelligent business men of these western states—and such men are many—and the masses contend these things can best be secured through irrigation, supplemented by a proper system of forestry to conserve the moisture on the mountains and the plains. And from time to time during late years, there have been held in different states irrigation conventions, to discuss these great questions.

Three of the most notable of these gatherings of the western representatives were in the form of international congresses. The first, in Salt Lake City; the second, in Los Angeles, Cal., in October, 1893, and the third, the first week of September, 1894, in the city of Denver, Colo. Circumstances were such that the writer could not attend any of these congresses, though, being on the committee on resolutions of all these conventions, North Dakota thus had a voice in the proceedings. I am pleased to remember that our worthy governor selected able delegates, Dr. M. F. Merchant, of Ellendale, and F. Wallace, of Bismarck, to attend the last congress at Denver.

Delegates were present from 23 states, besides Canada and Mexico. The national government was represented by F. H. Newell of the geological survey, Morris Bien of the general land office, while Captain W. A. Glassford represented the weather bureau.

Though all members of these three congresses were a unite on the necessity and paramount importance of irrigation, there was a division of sentiment. One wing contending for the cession of the public lands to the states to be used for irrigation purposes, and the other wing insisting that the national control was the wisest policy. But no final action was reached upon this point in such a manner as to take any practical form.

But numerous important resolutions were passed. One favored the immediate and unconditional repeal of the Desert Land law; another, favored the creation of a national irrigation commission, analogous to the interstate commerce commission. This commission, it is sought, to be vested with the power to administer irrigation works undertaken by the federal government and charged with the duty of beginning the immediate and thorough investigation of the problem of interstate waters. This congress also favored the appropriation of sufficient money by the United States Congress for the surveys necessary to determine the location of lands susceptible of irrigation.

ADDRESS TO THE PEOPLE.

On the subject of reclaiming the public land it spoke as follows:

The fundamental idea of our policy is not the separation of state and national interests, but co-operation between these powers within their proper spheres. The great end in view is to reclaim lands now useless and make them fit to sustain a vast population under conditions which shall guarantee industrial independence and human equality. We recognize these public lands as the heritage of the American people, not as the spoil of private greed. We aim to deliver to the people this precious birthright under conditions which will burden them only with the actual cost of reclamation and the return of the capital actually employed in the work, principal and interest. We recognize no private monopoly in the water which is the life current of the field, and hence of the man who lives thereon. We seek to inaugurate a policy which will settle interstate water contentions in a spirit of justice and equity. We aim to preserve and protect the forests and so to control the pastoral lands that the barbarism of frontier warfare shall be for ever eliminated and this portion of the public domain made useful to the largest number of people, under conditions which guarantee security. Upon these lines we hope to inaugurate a new era of industrial development, finding employment for labor and capital and security and satisfaction for both.

ON A FORESTRY POLICY AND THE CAREY LAW.

But while we are about to urge the necessity of important and far-reaching legislation, we do not forget to thank the Congress and people of the United States for what they have already done for western states and territories. We remember with gratitude the wise and patriotic action of President Harrison in establishing large forest reservations, and urge the continuance of this policy by President Cleveland. We heartily indorse the plan of Prof. Sargent, of Harvard university, providing for the education at West Point of skilled foresters, for a local forest guard and for the use of detachments of United States troops in guarding forest areas. It is impossible to exaggerate the importance of forest preservation to the economic life of Western America, because of its intimate relation to water supply for irrigation. We also note with satisfaction that a bill donating to each western state, under conditions, 1,000,000 acres of arid lands for purposes of reclamation recently passed the United States senate unanimously, passed the house with only nine dissenting votes and received the prompt approval of the President of the United States. We interpret this remarkable unanimity of action as an evidence of confidence in western men, of real concern for western institutions. And it is our purpose to avail ourselves of the opportunity thus given, and to make the Carey law the first step in the development of a great internal policy.

We thank Congress for such appropriations as have been provided for the work of gauging streams, and in investigation of water supply, but urge that larger appropriations are needed.

PATRIOTIC TONE OF THE CLOSING SENTENCES OF THE ADDRESS.

We especially urge our countrymen to remember that in the true sense, the problems of the irrigation congress are of national dimensions and national import. The best solution of the difficulties that vex our statesmen and economists, is that solution which would provide idle, discontented or unprosperous people, first with labor and then with homes. Our panacea for existing unrest is the small, irrigated farm, producing what the family consumes, as well as a surplus for market, and giving to its occupants, by reason of its smallness, the benefits of neighborhood association. We ask only the opportunity and facilities to provide such homes for millions and so erect great states on what is now the voiceless desert. And this we seek to do in the name of our nationality, not in the name of individual states or sections. We know no flag except the flag of the union. We know no destiny except the destiny of the American people. And whatever we shall accomplish under the policies we annunciate will add directly to the glory and greatness of our common country.

William E. Smythe, editor of the Irrigation Age, says in regard to this congress:

A NEW "TRIPLE" ALLIANCE.

An important feature of the recent irrigation congress was the hearty co-operation which it developed between the people of the United States, Canada and Mexico. The convention greeted with hearty applause the chairman's statement: "We hail with joy and pride this triple alliance for irrigation on the soil of North America." No features of the long programme attracted more attention than the address of Senor Ybarolla, of Mexico, and Messrs. Pearce and Dennis, of Canada. In the former country irrigation is older than history, while in the latter the beginnings of the industry are more recent than the first irrigation congress, held in Salt Lake City, three years ago. Both countries are represented on the new executive committee and the bond of sympathy seems certain to be both fruitful and enduring.

FOR THE FUTURE.

The irrigation movement is accumulating a tremendous impetus, which is visible not alone in the West, but throughout the county. The work of organization and agitation, through national, inter-state, state and county associations, will go forward with renewed energy, from now until the next great international congress assembles at Albuquerque, New Mexico, in the autumn of 1895. That this movement is the hope of prosperity for millions, and that it will safeguard our institutions with a new bulwark of liberty, in the form of small landed proprietors, is the confident expectation of western men. Their appeal is to patriotism and the best spirit of humanity. They seek to build to the credit of their country, to the good of their race, to the glory of God.

These great congresses have been attended with most favorable results and should receive the fullest encouragement of all sections of our union, for they deal with two of the most vital problems of the age. They greatly tend to shape public opinion along the practical lines of the two great factors involved in the question of the highest states of agriculture and horticulture, to-wit:—irrigation and forestry.

And out of these deliberative bodies of the western representative men there will be evolved to a greater or less extent, in time, it is reasonable to conclude, a definite policy of reclamation, settlement and administration.

THE CAREY LAW.

At the close of the last session of Congress that body passed what is known as the Carey law, appropriating 13,000,000 acres of land to 13 of the western states, each to have 1,000,000 acres of the same for irrigation purposes. This land goes to the state on condition that it will organize and put into practical operation a system of irrigation. I have been unsuccessful thus far in securing a copy of this law, but have from what seems a reliable source these facts. The irrigation system must be established within seven years from the passage of the act, and that the land shall be owned only by actual settlers. Each settler must pay the state its stipulated price and he is limited to 160 acres, twenty of which he shall irrigate. This question is of momentous importance and is deserving of the serious consideration of our legislative assembly.

ARTIFICIAL TREE CULTURE.--Tree Claim in Grand Forks County.

THEY WHO AID

IN THE

Forestation of the State

ARE

HUMAN BENEFACTORS.

FORESTRY.

FORESTS CONSERVE THE ARTESIAN DEPOSITS.

The rainfall is the source of all artesian deposits. Then let trees and forests be developed whenever needed, and mountains, hills and plants, to trap the snow of winter, to retard evaporation and shade the waters. Thus conserving the moisture, our artesian wells, being fully supplied, may flow on continually.

THE GREAT INTERNATIONAL FORESTRY AND SURFACE WATER SYSTEM.

The losses in the West for the last 50 years, resulting from drouths and hot winds, would amount to many billions of dollars. Now if this marvelous amount of money, or its equivalent,, could have been used in creating vast forest belts, 500 miles long and 50 to 100 miles wide, more or less, just where needed, together with a great comprehensive surface water system, over the entire 700,000 square miles that constitutes the great arid and semi-arid plains of the West, then a most favorable climatic change would have been produced, whereby drouths would probably have ceased, precipitation have been promoted, and agriculture and horticultural developments been increased to a most favorable extent for the enrichment and happiness of the people.

Such a system or systems of combined forests and surface water would produce the proper balances of the elements of nature in the West, and would practically solve the problem of drouths and hot winds, that periodically scourge the West, entailing inexpressible losses and want, and retarding the development of the resources of these natural garden lands of the union.

The vast surface water system and the great forestry system—broad, comprehensive and international—should be extended from far into Mexico, through our great West, and far up into the British possessions.

To consummate the scheme would require vast outlays of money, much labor and great executive management. But it would finally pay man in a thousand ways. Though great the undertaking, it is worthy of consideration, for the practical beneficent good that would of a necessity result therefrom.

TREE BOUNTY.

The amount of bounty paid by the State of North Dakota to encourage tree culture—three dollars per acre each year, for a period of 10 years, after the successful cultivation of the same for three continuous years—amounts to near $2,000 per annum.

The bounty paid in Minnesota for the same purpose is $2.50 per acre, limiting the bounty to each person to $20 per annum. The tree bounty law in that state dates back to 1873. According to the records, 74,000 acres of forest trees, exclusively under the operation of the law since its enactment, have been successfully raised on the prairie regions of that state. The aggregate of all the planting in that state during the last 10 years tallies all of 100,000 acres. And during the last 40 years the domestic trees raised in that commonwealth is well nigh the billions. The amount of tree bounty paid by that state since the law went into operation is not less than $100,000.

What has been done in Minnesota in the way of raising domestic trees may be more than done in North Dakota—the natural forestal lands of the West.

PLANT CLOSE.

The Bible says: "No man liveth to himself." How true! He must have companionship or he ceases to be man, in an ethical sense. The social develops him in fitness to rise. It is so with trees and flowers. One tree alone cannot break the wind; many enmasse can. Even our native trees become stunted and diseased if unsupported by companions, to help in the struggle for existence. Plant your trees close and thus secure shade from the very things you plant; that is nature's way. It works well; I can testify by actual experience, as well as observation. Then thin out in due time, and by the law of the fittest to live, you will sooner have a forest worth the cost. The safest way is to copy nature as nearly as possible. She is wiser than us all.

A WASH FOR TREES.

A wash for trees is made as follows: Dissolve one pound of copperas in two quarts of boiling water. Add this to a pail of ordinary lime whitewash. This will cause it to thicken. Add a handful of common salt. Thin with water.

The wash is now ready for use and can be kept in a cellar, ready to apply at any time, by not allowing it to dry up. Apply to trunk of tree in May and June, to keep out borers. Apply in fall, to keep off rabbits. Applied last of January or first of February, will prevent sun scald. This wash is cheap and easily applied and is useful on all kinds of trees.

EVAPORATION.

Evaporation is the result of the ever active agency of heat and electricity. It is one of the processes by which plants grow. Without it all life would cease upon the earth. It is also a cooling process, self-inductive to precipitation.

It occurs at surfaces. The greater the water or leaf surface (thickness a factor), the greater the rapidity of evaporation.

Cold lessens the capacity of the air to hold vapor; heat increases the capacity.

The drier the air, the greater is the rapidity of evaporation.

Hence, in the North Dakota climate, the absolute necessity of great water and leaf supply to produce rapid saturation of the aerial fluid for the needed precipitation.

LAWS OF PRECIPITATION.

Heat expands moisture; cold condenses it.

Warm air can contain more moisture or vapor than cold air.

Vapors afloat in the air, when chilled down so as to coalesce, form mist, snow, rain, hail, just as the aerial condition necessitates.

"Mountains act as condensers," says Prof. Tyndall ("Heat as a Mode of Motion," p. 384), "partly by the coldness of their own masses, which they owe to their elevation." Cold wind may produce the same result. If the wind is comparatively warm and laden with moisture, it (the moisture), says Huxley, "will be readily precipitated on exposure to refrigerating influences."

FOREST TEMPERATURE.

Ordinarily the temperature of the air under and just over a forest is considerably lower than that over an open field; if a vapor-laden wind blows over the forest there is a tendency to precipitation. The trees with their living foliage and carpet of dead leaves, and the extra moisture thus economized, make larger surfaces for heat absorption, preserved in latent state. Being thus shielded, the forest is cooler in summer and warmer in winter than the open field. When the leaves fall in autumn, they are retained on the ground, and over them is spread an even mantle of snow, thus preventing the penetration of frost to any great extent, and rescuing the roots of the trees and any tender flora from injury.

Prof. Tyndall shows that the heat-absorbing power of the air is almost entirely dependent on the presence of water vapor. As the dense forest is more moist than the open field—the former being better shielded and having more wet ground protected from the direct action of the wind—a thicker and wider spread curtain of vapor hangs over the forest, absorbing the sun's heat, intercepting its drying tendencies and reactions to damaging frosts, and so balancing the temperature, the coolness or warmth of the forest air is kept steady and salubrious. A cold wind or chill of the air in a vaporous strata of the forest generally causes precipitation, but not always. The relative conditions of the air determine this. If a cold air wave charged with moisture meets a warmer, drier wave, the tendency to precipitation is neutralized, the moisture being then scattered and lifted as vapors to higher altitude.—*Progressive Age.*

MAKE THE HOME ACRE ATTRACTIVE.

"How desirable, and, considering the value of the result, how inexpensive to make the acre on which the farm house is situated the most charming and delightful spot on earth to the owner and his contented family! Protected by thick trees from the blighting blasts of winter, he may, in comparison with the denizen on the treeless prairie, measurably defy old Borealis Rex in his winter's wrath; and in summer, his advantage over his unfortunate neighbor is still greater. Instead of pitiless sun pouring down his burning rays upon an unshaded roof, he has a little eden around him. The same friendly branches which arrested the rough winds of winter now defend him from the scorching heat. The green grass of the lawn and the bright flowers refresh his eye; the winds waft him perfume, and the trees are vocal with the sweet music of the birds."—*Prof. W. W. Pendergast.*

THE VALUE OF CLOSE PLANTING.

Prof. E. Gode, of Kansas, says: "Trees should be planted closely—

1. For the mutual protection of the trees.
2. For economy in culture.
3. For immediate protection.
4. For the purpose of securing available timber.
5. For the purpose of securing early returns from our planting."

MIX THE DIFFERENT SPECIES.

It is the opinion of experienced men that forest trees of different species ought to be mixed. Their differences of shade and chemical affinities are mutually supporting.

TREES INJURED BY THE HEAT OF THE SUN.

When trees are found to "blister" on the southside, when exposed to the direct rays of the sun, shade them with boards or screens. But by planting closely, little or no injury occurs from the "blistering," because a dense shade shelters the trunks of the trees.

NATIONAL TIMBER RESERVES.

On March 3, 1891, President Harrison approved of the act of Congress, giving the chief executive the right to create national timber reserves out of the woodlands of the public domain at such points as, in his judgment, would be promotive of forestry and the conservation of waters necessary for agricultural productions.

Under the administration of President Harrison, by his proclamation, 4,500,000 acres of national forest lands were set aside as national timber reservations. And during the administration of President Cleveland the number has been increased to date, (Dec. 1, 1894) to 18,000,000,000 acres.

These reserves are located thus:

In Colorado, that of the White River plateau, of more than a million acres; the Pike's Peak, of nearly 200,000 acres; the Plum Creek, of about the same dimensions; the South Platte, of more than half a million acres; and of the Battlement Mesa, of over 800,000 acres. In New Mexico, that of the Pecos River, of over 300,000 acres. In Oregon, that of Bull Run, of nearly 200,000 acres; that of Cascade Range, of about four million and a half acres; and of Ashland, embracing nearly 19.000 acres. In Wyoming, the addition to the Yellowstone National park, of nearly a million and a quarter acres. In California, the San Gabriel, of over half a million acres; that of the Sierra, of over 4,000,000 acres; of the San Bernardino, of over 700,000 acres; and that of the Trabuco Canyon, of 50,000 acres. In Washington, that of the Pacific, of nearly a million acres. In Arizona, that of the Grand Canyon of the Colorado, of over 1,800,000 acres. In Alaska, that of the Afognak Forest, and Fish Culture reservation, embracing the whole island and circumjacent rock and waters.

In order to put this matter in a more condensed form I give below the

ACREAGE RESERVED IN THE UNITED STATES.

The forest reservations proclaimed by the President, under the congressional act of March 1, 1891, are divided as follows in the different states and territories:

	Acres.
Alaska	1,851,520
Arizona	355,520
California	6,238.720
Colorado	3,101,360
New Mexico	311,040
Oregon	4,653,440
Washington	967,680
Wyoming	1,239,040

THE TURTLE MOUNTAIN TIMBER RESERVE.

As time passes the advantages and necessity of the Turtle mountain timber reserve become more and more apparent to those who investigate the subject. As our population increases, the necessity of a perpetual fuel supply becomes more fully understood. Of course, the dry and down timber, and the old trees, that should be removed to make proper forest conditions, are not enough to furnish the State at large with fuel. But the people in the vicinity of the mountains can, as in the past, have an ample supply of wood material from that source, so long as the timber of the reserve shall be preserved. And there can be no question but the forests on those hills tend to conserve the vast amount of waters found thereat. These waters flowing from these uplands in way of streams and coulees and the underflow have a direct and very great effect in keeping up the water supply of lakes and streams located south, east and west.

Below I give some reasons why we need the Turtle mountain timber reserve.

That the trees and forests may there conserve the following purpose:

First.—To form a shelter against the cold winds of the north and the dry and hot winds of the west and southwest.

Second.—To retard the melting of snow.

Third.—To retard the rapid flow of water in the spring.

Fourth.—To retain a greater water supply for the dry summer.

Fifth.—To shield and hold the rains that find lodgment on the forest flora.

Sixth.—To protect beneath their foliage the natural reservoirs, namely: Springs, lakes and rills as the sources of the streams and rivers of the prairie lands, whose waters furnish moisture to the atmosphere and the earth.

Seventh.—To retard the too rapid evaporation of surface water of the mountains.

Eighth.—To economize those waters that maintain the underflow, which in turn furnishes waters to the settlers and moisture to vegetation upon the plains.

Ninth.—To cool, subdue and temper the atmosphere, and, as far as the laws and conditions of the trees alone or in compact bodies will allow, to aid in producing moisture and precipitation.

Tenth.—To furnish a perpetual supply of fuel and other forest products for the surrounding treeless region.

Eleventh.—To furnish tree seedlings for planting on the plains.

Twelfth.—That the reserve may in time become one of the national nurseries for the forestation of the country.

Thirteenth.—To serve as an illustration of the requirements of successful tree culture.

Fourteenth.—To furnish a place of retreat and recreation for the people of the adjoining plains and the neighboring towns, and for the people at large.

Fifteenth.—To there adorn and beautify the uplands for the gratification of æsthetic culture, which constitutes an important element in the highest status of a practical and progressive people.

Sixteenth.—To aid in the production of the best conditions for the highest development of agricultural pursuits.

Seventeenth.—That the trees, properly protected and cultivated in a compact body, may there perform their highest functions and exert their most beneficial influences upon the earth and sky, and upon animal and plant life, promotive, in connection with other favorable agencies, of the health, prosperity and happiness of the people.

NORTH DAKOTA THE ORIGINATOR OF THE NATIONAL TIMBER RESERVE SYSTEM.

The Turtle mountain timber reserve has not yet been permanently established by proclamation from the President.

The national timber reserve system is fraught with great benefits to our nation and its people. The amount of timber permanently reserved to date (December, 1894), amounts to 18,000,000 acres. And it is most creditable to North Dakota that one of her discerning and far-seeing sons—Hon. H. C. Hansbrough—was the author of the bill creating the law embodying this, the timber reserve system, leading the way to a more rational, substantial forestry policy.

THE INCREASEMENT IN THE CONSUMPTION OF THE TIMBER OF THE NATION.

There is a constant increasement in the yearly consumption of the timber of the United States. During the last three decades the increasement has been about *30 per cent* in the amount used for *each decade*, and as our consumption—not counting losses by fires—amounts to 12,000,000,000 cubic feet of lumber per annum (about 350 cubic feet per capita) in *excess* of the yearly growth, as has been stated elsewhere, it can be seen how enormous must be the consumption at the end of the next 50 years! Should we not economize our present supply and plant new forests?

FACTS TO REMEMBER.

Total area of timber lands in the United States, less than 500,000,000 acres.

Total amount of wood consumed for legitimate purposes, 24,000,000,000 cubic feet per annum, worth approximately, $1,000,000,000—that is to say, more than the total value of the annual crop of wheat, rye, oats, potatoes, cotton and tobacco of the union.

Per capita of consumption, about 350 cubic feet.

Total amount of wood destroyed by fires is estimated to be 5,000,000,000 cubic feet per annum.

Total loss of timber by fires is computed to be on an average of $2,000,000 per state and territory each year.

The increase of consumption is about 30 per cent. each decade.

The area of the timber cut in the United States, if placed in one tract, would amount *each year to 25,000,000 acres*—equal to about 4,800,000,000 cubic feet of lumber.

To furnish the present consumption of 24,000,000,000 cubic feet per annum, not less than 1,000,000,000 acres of forests would have to be kept in good productive condition, while at present less than half (500,000,000) acres exist, which is culled without regard to future supply.

Do not these figures suggest the necessity of a rational national forestry policy?

ARBOR DAY.

The history of Arbor day is worthy of study. It was originated by J. Sterling Morton in 1872, who was then the acting governor of Nebraska, and now the secretary of the National Agricultural Department. Since that time, it is claimed, over 700,000 acres have been planted to trees by human hands in that same state. The idea has spread until at this time all states and territories observe Arbor day, except Arkansas, Delaware, Oklahoma, Indian Territory and Utah. And it is also observed in England, Scotland, France, and even in far away South Africa.

Arbor day has been faithfully observed in North Dakota ever since it became a state.

Much interest was awakened on last Arbor day, May 4, 1894, in all parts of the State. Most elaborate, appropriate and entertaining exercises took place in connection with the public schools of Grand Forks, Fargo, Jamestown, Bismarck and all the large cities of the State. But these pleasant exercises were not restricted to the cities alone, as the day was most generally observed in the various rural districts of the commonwealth.

THE FIRST SYLVATON CELEBRATION IN NORTH DAKOTA.

At Church's Ferry on that day (May 4, 1894) the exercises took the form of a *Sylvaton celebration*, being the first celebration of the kind in North Dakota. The gathering was large and not only attended by all the children, but by their parents and guardians, the leading prominent business men of the village lending their presence and influence to the occasion. The exercises of the children were of the most entertaining and enjoyable nature. Trees were planted and dedicated and are hardy and thrifty at this time. The writer gave a history of the Sylvaton movement and entertained the audience with a display of the official announcement of the awards on the North Dakota forestry exhibit at the World's fair, the official ribbon, etc.

Most favorable results have accrued from that much enjoyed celebration. This is made manifest in the deep and earnest interest which those children have manifested in the question of tree culture since that pleasant and instructive event.

Thus the Sylvaton idea is taking root and growing, and the harvest is full of gladsome promise.

STATES AND TERRITORIES OBSERVING LABOR DAY.

States.	Year of First Observance.	Time of Observance.
Alabama..........	1887	22nd of February.
Arizona...........	1890-1	First Friday after 1st of February.
California........	1886	
Colorado..........	1885	Third Friday in April.
Connecticut.......	1887	In spring, at appointment of governor
Florida...........	1886	January 8.
Georgia...........	1887	First Friday in December.
Idaho.............	1886	Last Monday in April.
Illinois..........	1888	Date fixed by governor and Supt. of Public Instruction.
Indiana...........	1884	Date fixed by Superintendent of Public Instruction.
Iowa..............	1887	Date fixed by Supt. Pub. Instruction.
Kansas............	1875	Option of governor, usually in April.
Kentucky..........	1886	“ “
Louisiana.........	1888-9	“ Parish Boards.
Maine.............	1887	“ governor.
Maryland..........	1889	“ “ in April.
Massachusetts.....	1886	Last Saturday in April.
Michigan..........	1885	Option of governor.
Minnesota.........	1876	“ “
Mississippi.......	1892	“ Board of Education.
Missouri..........	1886	1st Friday after 1st Tuesday in April.
Montana...........	1887	Third Tuesday of April.
Nebraska..........	1872	22d of April.
Nevada............	1887	Option of governor.
New Hampshire.....	1886	“ “
New Jersey........	1884	“ in April.
New Mexico........	1890	Second Friday in March.
New York..........	1889	First Friday after May 1.
North Carolina....	1893	
North Dakota......	1890	By proclamation of governor.

STATES AND TERRITORIES OBSERVING LABOR DAY.—*Continued.*

States.	Year of First Observance.	Time of Observance.
Ohio	1882	In April by proclamation of governor
Oregon	1889	Second Friday in April.
Pennsylvania	1887	Option of governor.
Rhode Island	1887	" "
South Carolina	Uncertain	Variable.
South Dakota	1884	Option of governor.
Tennessee	1875	November, at designation of County Superintendents.
Texas	1890	22d of February.
Vermont	1885	Option of Governor.
Virginia	1892	
West Virginia	1883	Fall and spring at designation of Superintendent of Schools.
Wisconsin	1889	Option of Governor.
Wyoming	1888	" "
Washington	1892	

Only the following five states or territories fail to observe Arbor Day—Arkansas, Delaware, Oklahoma, Indian Territory, Utah.

ARBOR DAY PROCLAMATION.

"What does he plant who plants a tree?
He plants cool shade and tender rain.
And seed and bud of days to be.
And years that fade and flush again;
He plants the glory of the plain;
He plants the forest heritage;
The harvest of a coming age;
The joy that unborn eyes shall see,
These things he plants, who plants a tree."

In accordance with the sentiment of our people, and with the desire to encourage the manifest increasing interest in the adornment of our homes, public grounds and highways by the cultivation of trees and flowers, I hereby designate

FRIDAY, THE 4TH DAY OF MAY, A. D. 1894,

to be observed as Arbor Day in North Dakota. Let us all appropriately observe this day, and I trust that the work of individuals may be supplemented by the efforts of societies, communities and especially by the teachers and pupils of our schools.

Done at the capitol in the city of Bismarck, North Dakota, this 7th day of April, in the year of our Lord, one thousand, eight hundred and ninety-four.

E. C. D. SHORTRIDGE,
Governor.

[SEAL.]
By the Governor.
C. M. DAHL,
Secretary of State.

ARBOR DAY LETTER.

Prompted by a knowledge of the necessity and practical utility of forestry, by proclamation, our honored governor has designated May 4, 1894, as Arbor Day, to be observed by the people in the planting of trees and flowers.

NORTH DAKOTA POSSESSES ALL THE ELEMENTS NEEDED FOR TREE GROWTH.

Ours is a young State, but because of its great natural resources it already ranks amongst the foremost states in the West, and one of the most important of the elements here found is that of forest trees. These, constituting many thousands of acres of native timber, are found along our rivers and streams, on the mountains and hills, and around our lakes, whilst millions of young and healthy trees, self produced, are growing on the native plains, where the fires have been excluded.

In the early days of pioneer life, the progress in tree culture was slow and somewhat uncertain. This was owing measurably to the want of time to devote to the work, and a knowledge of necessary conditions and proper methods of cultivation required in order to secure success. But of late years, by an intelligent system of planting and tillage, together with sufficient moisture, sylvaculture has made the most gratifying progress with those who have given the subject that thought and attention which its importance demands.

NORTH DAKOTA'S WORLD'S FAIR AWARDS ON FORESTRY.

There can be no question in the minds of those best informed upon the question but North Dakota in climate, meteorological conditions and soil contains all the essentials needed for tree growth in their best development. These features are fully demonstrated in that within our borders we have many thousands of acres of healthy, vigorous and rapid growing domestic trees, the quality of which and likewise those of native growth, when produced under proper conditions, are equal in all points of excellence to like varieties of any other state or nations of the earth. This fact was recognized and acknowledged by the intelligent and considerate inspecting judges and management of the great World's Columbian Fair, where for superiority in all essential properties of forest productions our State secured two of the highest awards, being those of medals. One was given on the collective display of woods and the other on the exhibit on the pyramidal tower of forests and seeds, nuts, acorns and wild fruits of the commonwealth, in the collection of which the children of the State, under the name of the Sylvatons, displayed their love of and interest in forestry.

OUR STATE THE NATURAL FOREST SOIL.

Thus those seeking new homes and those who are now denizens of our realm have an evidence that our State by ample and proper planting and cultivation must, without doubt, become the forestal land of the West, the trees of which cannot but add much to the comfort and enrichment of the people who may fortunately dwell herein.

But in order to accomplish this desirable end, a more earnest effort should be made to plant more abundantly and to cultivate more thoroughly and judiciously trees and forests throughout our land. Hence the appeal made by our considerate executive, who is never undmindful of the practical good of the masses and the State, for a well ordered observance of Arbor Day.

LET ALL OBSERVE THE DUTIES OF ARBOR DAY.

In accord with those who believe a proper system of forestry is indispensably necessary for the best welfare of the State and the citizens herein, I respectfully but earnestly urge our people to heed the duties that will devolve upon them on Arbor day. To this end let the city fathers give aid on the occasion in way of providing speeches, songs, music by the voice and the band, and the planting of trees and other products of the forests or nurseries for ornamentation, beauty and health-giving elements, in the city parks, church and school yards, the cemeteries, and along the avenues and streets. Let the village trustees and leading men and women improve the corporation by planting the "children of the forests" in every vacant spot in the community. Let those in intellectual pursuits, and especially editors, all of whom in a high degree are molders of public sentiment, fail not to understand their duty and call out the masses from store, home, shop and bank, to plant and beautify the hills and plains afar and near.

OUR CHILDREN, THE FUTURE CITIZENS OF THE STATE, SHOULD BE TAUGHT FORESTRY.

But foremost in this good work should be our superintendents of county schools, principals and teachers in the higher educational institutions and the common schools. They have golden opportunities, for to their hands are committed the grave but pleasant responsibility of training those who are to soon constitute the men and women of the state. For this reason it is earnestly hoped all the scholars will be taught the necessity and great practical advantages, as well as the beauty and refining influence of tree culture. This can be accomplished to a favorable extent by such proceedings in form of recitations of prose and poetical selections, music and songs and other exercises, with the planting of trees, vines, shrubs and flowers—beauties of the Father's loving bestowment—as will lead, by pleasant steps, the mind and heart into the realm of nature wherein trees, alone, in grove or forest, constitute the chief object of attraction and admiration.

HOW TO PLANT TREES.

The trees selected for the planting should be sound and healthy, with ample roots, the broken ones of which should be carefully trimmed. The roots should be spread out naturally on the loose, rich dirt in the hole and covered with rich, fine soil, to be firmed judiciously with the foot. Put each tree at least one inch lower than it stood in the woods or nursery. If the top seems too abundant, trim back so the vitality of the roots may throw out new growths. When done, surround each tree with a mulch of old, rotten straw or other litter to retard too rapid evaporation. Let all the work be well done, remembering that one tree, which by intelligent and proper culture is made to live and grow, is worth ten trees that through ignorance and ill-treatment are sure to die.

THE PEOPLE'S HOME IS NORTH DAKOTA, THE SILVATON STATE OF THE UNION.

Thus let the day be observed by all members of the common brotherhood, both old and young, and the participants will become imbued to a full degree with a greater love for and clearer knowledge of the beneficient advantages or forestry, which, if cultivated as becomes an enlightened and progressive people will, in a great measure, tend to produce more favorable meteorological and climatic conditions, desirable in all countries; increase agricultural productions; afford protection to human and animal life, beautify and adorn the country, and materially enhance the wealth, comfort and happiness of the people. These blessings will of a certainty come from a full development of forestry, adding much to the progress and greatness of this, the commonwealth of North Dakota, which is the people's home and the silvaton State of the union.

W. W. Barrett,
State Superintendent of Irrigation and Forestry.
Bismarck, N. D., April 19, 1894.

NOTED MOUNTS AND HILLS OF NORTH DAKOTA.

In our State we have not only many attractive parks and Sylvan retreats and famous lakes and streams, dear to our people, the young and the old, but we also have numerous hills and mounts around which cluster many sacred associations because of their charms, beauty and interesting history. I cannot name them all, but present a few:

Mount Mokono, being Butte St. Paul, near 2,500 feet above the sea.

Mount Nokara, being the Devils Heart, near Devils lake.
Mount Knobo, of Nelson county.
Mount Winko, of Ramsey county.
Monnt Kimboview, of Ramsey county.

MOUNT KNOBO.

Many of our village and country public schools are not only attractive in architectural design and execution, but many have fine locations and beautiful environments. This is particularly true of the village school of Lakota. The grounds are extensive, and the site is in form of an oval hill, high, but easy of access. On its summit the large, imposing structure has been built, from whence a charming view of the village and the country for a long distance is obtained. The trees set out on various Arbor days are in excellent order and have made good growth. Last season (1894) some hundreds of tall trees were planted in the grounds, so the surroundings have an agreeable and favorable influence upon the pupils. A deep and enthusiastic interest is taken by the children of this school in the subject of forestry, and each Arbor day is faithfully observed by them and the adults.

A fine, flourishing Sylvaton society is connected with the school, and all the pupils and teachers and many of the parents are members of the same.

This attractive spot, the High school house and grounds of Lakota, dear and sacred to the children, and the pride of the community, county and the State, is known as "Mount Knobo," which signifies "the Mount of Wisdom," "circled knowledge and truth," etc.

FOREST FIRES.

What a lesson has been taught by the great fires which devastated the forests of northern Minnesota, Wisconsin and Michigan, during the last season—1894. The great holocausts have taught the absolute importance of practical stringent measures to prevent such direful calamities, the loss of property and destruction of human life.

The national government is already taking action upon th subject. A bill was recently passed by the House of Representatives looking to the suppression of forest fires in the national reserves, and the other woodlands of the public domain. The fire-injured states will also consider this serious question.

FOREST FIRES IN NORTH DAKOTA.

Will North Dakota be indifferent upon this question? During the last season (1894) many hundreds of acres of the Turtle mountain timber have been run over by the fires, and vast bodies of wood destroyed, much of which belonged to private individuals of the State. Many thousands of acres of the timber lands of the Turtle mountains have been destroyed by prairie fires since 1886. Should not our legislative assembly enact some wholesome laws by which the forests of the State shall be secured from destruction from fires originating from various sources?

THE BLACKEST CRIME.

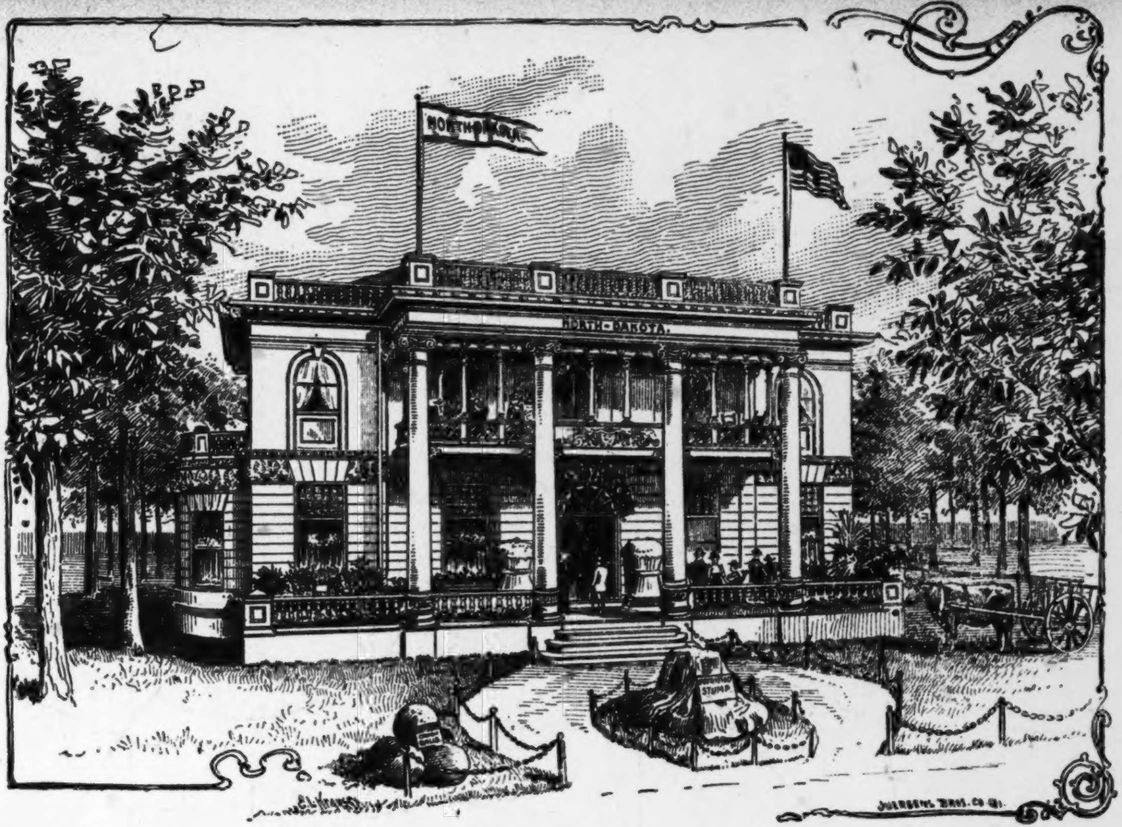
The recent devastation by forest fires in Northern Minnesota, Wisconsin and Michigan, pathetically confirms the wisdom and broad-minded forethought of the agitators for forest preservation and restoration, "the forestry cranks." It is announced that "fire bugs are responsible for the fires," and God is thanked for sending timely rains to extinguish a conflagration that threatened appalling consequences. The announcement is a lie, and the thanks are sacrilegious. The state is primarily responsible for the fire, working through its petted and pampered favorites. An attempt is made to compute the loss from these fires, in money; it can not be done. The lumber and timber destroyed, the homes made desolate, and the farms laid waste are but trifles in the complication, yet they are all that is computed. The young timber that should have been guarded and nursed into maturity for the use of those who come after us, and the soil that would have supported forests for generations of men yet remote, went out in the smoke and flames of those awful fires. Those who can fully appreciate and correctly estimate the real loss consequent upon the destruction of forests, that we now encourage, are yet unborn. A proper administration of our forests, the enforcement of certain simple regulations, the small expense of a given supervision, the utilization of an infinitessimal percentage of the profits of our forest despoilers would secure ample forests, and cheap and abundant timber for posterity; while under existing conditions treeless wastes of nude and blackened land will be the scroll upon which our children and our children's children will read the record of our indifference, selfishness and greed. Neglect of forests, of their preservation and restoration, is one of the blackest crimes of our history.—*Farm, Stock and Home.*

THE WORLD'S COLUMBIAN FAIR OF 1893

MARKED THE NEW EPOCH

—IN THE—

HIGHER CIVILIZATION.


NORTH DAKOTA
NORTH DAKOTA.
STUMP
JUERGENS BROS. CO. CH.

NATIVE TREE TRUNKS FOR THE WORLD'S FAIR.

Complying with instructions from the World's Fair State Board, on June 1, 1892, I shipped, via the Great Northern railway, from Grand Forks, eight tree trunks for the colonnade of the great Forestry building of the World's Columbian Fair. All were well protected by means of paper and scantlings. These tree trunks were procured in the Sylvaton park, and constituted the first shipment of any exhibits of any kind from North Dakota to the great fair.

These tree trunks were placed in the northeast corner, being near 60 feet, however, from the northeast corner of the colonnade of the Forestry building. They made a most creditable and fine display, equal to the best from other states. They were all properly labeled so the thousands of the denizens of the earth, who daily visited that remarkable structure, found pleasure in the knowledge that our prairie State was not without timber, and that the splendid, handsome, straight and sound were worthy of any state or nation.

The trunks consisted of one cottonwood (yellow) 25 feet long, 16 to 20 inches in diameter at the base.

One basswood 25 feet long, 16 to 20 inches in diameter at the base.

Two oak (white) 25 feet long, 9 to 12 inches in diameter at the base.

Two elm 25 feet long, 9 to 12 inches in diameter at the base.

One ash 25 feet long, 9 to 12 inches in diameter at the base.

One hackberry, 25 feet long, 9 to 12 inches in diameter at the base.

And 32 rustic pieces were sent, being from five to 16 feet long and from four to 9 inches in diameter.

All trees from all states and nations were limited to the above size and length.

THE FORESTRY EXHIBIT

—OF—

NORTH DAKOTA,

The Sylvaton State of the Union.

Sufficient Forestry and Water Gives Glory to the
State and Joy to the People.

VARIETIES OF TREES FOR THE WORLD'S FAIR.

Near 45 varieties of native woods were prepared by the writer for the World's Columbian Fair. These were duplicated, making at least 350 specimens, straight, sound and handsome. Below I give the size of some of the larger trees sent to the Fair, sending in the form of sections cut four feet long:

White oak	33 inches in diameter and 80 feet tall
Hackberry	16 inches in diameter and 53 feet tall
Ash	28 inches in diameter and 75 feet tall
Cottonwood	42 inches in diameter and 95 feet tall
White willow	18 inches in diameter and 70 feet tall
Basswood	32 inches in diameter and 82 feet tall
Elm, near	36 inches in diameter, near 75 feet tall

I did not seek to get our largest size trees, such as the oaks, elms, basswoods and cottonwoods, that grow four, six, six and a half and seven feet or more in diameter, the object being to furnish characteristic trees.

The forest seeds, acorns, nuts and wild native fruit collected and displayed in glass bottles, globes and urns, constituted over 50 varieties, put up in over 350 vessels, making in woods and inclosures in glass (counting each bottle or globe as one specimen) over five hundred specimens as the forestry exhibit of North Dakota at the World's Columbian Fair, on which two awards, consisting of a diploma and a medal in each case, were given, one to the State in woods, and one (based upon the Sylvaton idea) to the writer and the Sylvaton exhibit.

The larger specimens of all wood represented the bark intact. They were four feet long and showed in each instance, by proper preparation, the heart and sapwood by three planes, transverse, radical and oblique. But, however, some were prepared by four planes, towit; transverse, radical, oblique and targlutial. One-half of the plainer wood showed the natural and one-half the polished surface executed in the most attractive manner. Each specimen was labeled with the common and the botanical name. These woods were equal in all respects to like varieties from other states and nations of the globe.

THE GOVERNOR BURKE RUSTIC OAK CHAIR.

In the North Dakota pavilion of the Forestry Building, where the State exhibit was given, two conspicuous specimen ornaments of our forestry exhibit attracted much attention. One was a famed oak chair, with handsome hand carving, furnished by the ladies of Grafton. The other was a chair made by excavating part of the wood from a section of an oak tree. It was a most comfortable seat and constantly occupied by the thousands of visitors who daily sought the Forestry Building. This novel, unique and handsome chair was *the only one of the kind* in the whole mighty fair, and it was known as the "Governor Burke Rustic Oak Chair."

THE RUSTIC LETTERS.

The rustic letters, which circled the entrance to our State building and the entrance to our forestry exhibit pavilion, were prepared by myself with the *greatest care.* They were made from the small trees, native and domestic, of our State. The sections displayed with the bark intact. There were three sets—"North Dakota" and "Forestry" for the forestry exhibit, and "North Dakota" for the State building. These well made and artistic letters added much to the novelty and attraction of the State's exhibits.

A LIST OF THE WOODS EXHIBITED.

The following is a list of the woods contained in our exhibit:

Various kinds of oak, ash, elm, birch, hackberry, box elder, willow, poplar, balm of Gilead, cottonwood, basswood, arbor vitae, pine, ironwood, prickly ash, dogwood, saneac, haw, plum, thorn, cherry, buffalo-berry, (the only exhibit of this tree or bush in the entire fair), juneberry, hazel bush, high bush cranberry, wild grape.

Numerous fine specimens of our domestic trees were also furnished, consisting of cottonwood, box elder, poplar, willow, etc.

The following persons contributed wood material for our exhibit:

Hon. James McCormack, Penn; R. J. Walker and A. J. Kildahl, Church's Ferry; John Gill, Jackson; Henry Hale, Devils Lake; Burge Bros., Williston; Joseph Denoyer, Williston; Thomas Hesketh, Rolla; Captain E. W. Brenner, Rolla; A. J. Hart, Lake Metegaske; E. W. Haseltine, Grand Forks; James Holland, Bismark; Robert Reese, Grand Forks; A. E. Hoadley, Graham's Island; W. H. Kirk, Lake Metegaske; W. W. Barrett, Church's Ferry; Robert Rowan, E. R. Ramsted, Minot, and Joseph Greenwood, Grand Forks.

THE TWO SYLVATON TOWERS.

The specimens of forest seeds, acorns, nuts and wild fruit were put up by myself with thoughtful and studious care, and displayed on two towers—the Sylvaton tower and the Laba tower—in the center of the exhibit, the woods occupying the four sides of the well located pavilion.

The fine specimens and novel glass vessels afforded an opportunity for an artistic, novel and instructive display. This, added to the fact that this display was wholly unlike anything in the forestry line in the entire fair, it became the center of attraction to the vast throngs of daily visitors, who admired the work and commended the school children—the Sylvatons of North Dakota, for their industry and attractive display—"object lessons" of a pleasant suggestion and instruction in the direction of the forestal education of the western children.

ALL SCHOOLS OF NORTH DAKOTA WERE REPRESENTED IN THE SYLVATON EXHIBIT.

The following named schools assisted in collecting seeds, nuts, acorns and wild fruit:

Lake Metegaske, Turtle mountains, Rolla, Minot, Church's Ferry, McLein, Walla, Coulee, Irvine, Devils Lake, Ramsey county; Lakota, Nelson county; Graham's Island, Benson county; Grand Forks city schools, State university, Catholic seminary, Blackburn school and two other schools in Grand Forks county.

As the lateness of the season would permit of no more school excursions into the woods, the representative forest seed collectors were authorized to collect for different sections, and thus every school in North Dakota was represented in the noted North Dakota Sylvaton exhibit at the great World's Fair.

THE SYLVATON SEED COLLECTION EXCURSIONISTS CAUGHT IN A SNOW STORM.

Many varieties of the forest seeds and wild fruit of our State were not procured because of the lateness of the season, when they could not be found. Not a few specimens were secured by myself on and in the snow in the winter time. Indeed, in some instances, I was obliged to remove the snow to the depth of over two feet in order to find some desired specimens. This I did in the Sylvaton Park. The last excursion for the collection of seeds made by the Grand Forks schools, State university, etc., was caught in a storm of sleet and snow, but nevertheless, enthusiastic in the pleasant work, a fine collection of specimens were secured and made conspicuous in the Sylvaton exhibit.

THE INSTRUCTIVE TEACHINGS OF THE WORLD'S COLUMBIAN FAIR.

I venture to say the great colossal World's Columbian Fair was, without doubt, the most wonderful, and the results will be the most beneficial, of all the world's expositions. To my mind it seemed the beginning of a new age, a golden epoch of the history of the world. It was surely the highest and best manifestation of human progress in the way of the cultivation of the earth and the fruits thereof, and also in the realm of discoveries and inventions, and the fullest display of the practical and aesthetic production of brain and hand of all the nations of the world that has, as yet, been presented in the collective form for human attention. The great primal and necessary industries of mankind, such as agriculture, horticulture, animal industry, fish culture, forestry and irrigation, were arrayed in massive grandeur and fascinating systematic order. These, and all the practical things there displayed, including the application and use of electricity, and the machinery involved therein, in the way of transmitting thought, light, driving machinery, heating purposes and cooking of foods, the phonograph system, the marvel of wonders, the photographic art, man's master control of the sunlight for the matchless picturings of God's creation, gave the most ample evidence of man's progressive advancement. Nor was this all; the language, literature, architecture, sculpture, musical instruments; the matchless sciences and arts and all the enchanting and sacred works of pen and brush—nature's beauty, born anew through the soul's inspired creations—these, and the thousand other nameless works of man, demonstrated the exalted status of the world's intelligences. There in the marvelous "White City" and in the great congresses multitudinous phases of thought, sentiment and development, and nearly every needed reform seemed fully presented for the consideration and beneficient good of the eager multitude. There, too, in that, the new school of human progress, the children, women and men, according to the true principles of civilization, received fair and full recognition, a principle which heretofore has never been fully recognized in other international fairs.

All these things betokened the exaltation of human greatness, and furnished supreme evidence of the mind's capacity over the things of land, water and sky and the elemental forces thereof. It proved to be the great object school of the children of men, the teachings and inspirations whereof tending to awaken the highest eloquence and profoundest thought in prose or verse. Its lessons, its beauty, its quickenings and its glory will go down through the coming ages as the great practical reformatory and guiding light, lifting the race into a harmonious brotherhood wherein intelligence, science, purity, goodness and true christianity shall appear in all their ennobling and saving powers.

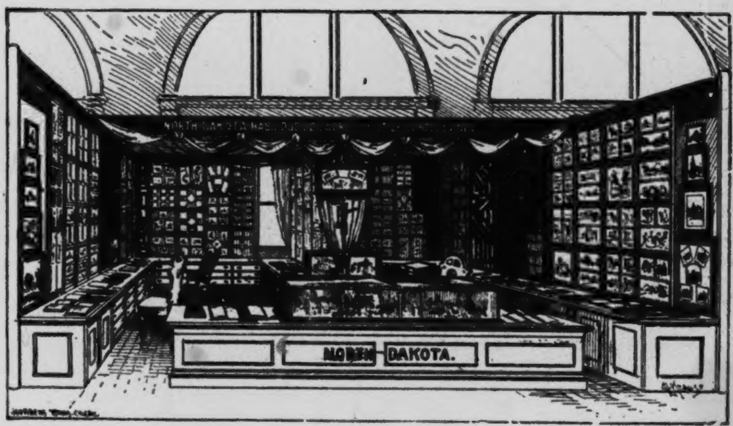
The great Columbian museum has been born of the World's Fair, and it is destined to become the great object lesson college of the earth.

METEOROLOGY

The elements of nature are the Providential gifts to man, who becames master of the same for beneficent good in the ratio of his scientific attainments.

As the State has made provision for the printing of the weather observations by the director of the North Dakota weather service, it becomes ~~necessary~~ to present them in this report.

unnecessary


NORTH DAKOTA.

TEACH FORESTRY.

IN ALL THE SCHOOLS OF THE STATE AND THE PRESENT AND FUTURE GENERATIONS WILL BE BLESSED THEREBY.

THE STATE SCHOOL OF FORESTRY OF NORTH DAKOTA—THE FIRST AND ONLY SCHOOL OF THE KIND ON THE WESTERN CONTINENT.

By virtue of the constitution of North Dakota, embodying the true principles and the most advanced thought of the higher civilization, provisions have been made for a State School of Forestry, to be located in the northern part of the State; and thus we have assurance the school will be created. Indeed, at the last annual election, in November, 1894, a vote was taken on the location of this school, but it is not yet determined whether it will be located at Bottineau or Minot.

NORTH DAKOTA STANDS WITHOUT A PEER.

The State of North Dakota has need to be profoundly thankful and becomingly proud of the works, and deeds, and practical progress of our commonwealth. We are not great in war, though our soldiers were "the bravest of the brave," in saving our union and perpetuating freedom in the land. But our greatness, our wisdom and our advancement is seen along the line of political, intellectual, moral, religious and economic reforms. We stand without a peer; no state, no province and no nation of ancient or modern time has been or is our equal in things whereby we are appreciated. Wherein are we distinguished with, and above, the brotherhoods and sisterhoods of the commonwealths and the nations of the earth? Shall we name them? Yes, with the pride of devoted children.

Our constitution, our laws, our homes, our schools, and our churches are amongst the best in the world. Our press is the freest and the most enlightened. Our society partakes of the higher elements that pertain to an advanced people. Our railroads, steamboats, telegraphs, telephones and electric lights betoken mental power and cunning skill. Our artesian wells, probing the crystal depths of the largest artesian deposit upon the globe, demonstrate our wisdom in bringing to light the hidden elements, which, intelligently used in practical application, will re-edenize this, the garden lands of the West. Our forestal developments, considering the limitation of time, circumstances and conditions, are equal to those of all the West, and demonstrate our State is the natural tree land of the western world. Our wild animals, fish and game are abundant and amongst the best. Our grains and fruit are so great and bountiful that we have become known as the "bread basket of the world." Our soil, our waters and ou climate are not surpassed. Our men, our women and our children stand high in the order of physical, mental, moral and spiritual development, and here plenty, peace and happiness abound. And we have millions of our acres of rich virgin lands to *give free of charge* to all who would come and abide with us.

We are the first and only state to make a woman the state superintendent of public instruction.

We are the first people to comprehend the correlation of irrigation and forestry and are the first and only state or nation to manifest true wisdom by embodying the two systems in one state department.

We are the first and only state in the union, or any nation of the globe to perfect a system and put it into operation for the enlistment of the school children of the state, as we have done throught the Sylvaton organization, in the subjects of forestry, irrigation and co-ordinate branches.

We are the only state or nation of the globe to win an award at the great World's Columbian Fair on a collective exhibit of forest seeds, acorns, nuts and native wild fruit collected by the co-operative work of the children of the state.

We are the state that originated the great and comprehensive system of national timber reserves in the interest of forestry and the conservation of the water supply of the country.

WE ARE THE FIRST AND ONLY STATE OR NATION OF THE WESTERN CONTINENT TO ESTABLISH A STATE SCHOOL OF FORESTRY.

This school is of such vital importance that it would be wise, as I understand the matter, to unite and ask Congress to appropriate five hundred thousand acres of government land as an endowment, that its practical utility may be more fully demonstrated.

He who plants an oak looks forward to future ages and plants for posterity. Nothing can be less selfish than this.—*Irving.*

To me the meanest flower that blooms can give thoughts that do often lie too deep for tears.—*Wadsworth.*

CAN EASILY BE MADE THE LAND OF HOMES.

It was gratifying to observe what favorable impressions our North Dakota forestry exhibit had on the visitors at the World's Fair.

Many, amounting to hundreds, of intelligent and considerate persons not only expressed great surprise but pleasure to discover by the samples of wood, seeds and wild fruits before them that trees flourish and forests abound in our State. I remember one man in particular who expressed himself in nearly this language: "I have seen your exhibit of grains and grasses in the Agricultural building and found the proof that North Dakota is the land of grain and grass, and now I discover with astonishment that your State is not wholly treeless. These specimens of wood make clear to my mind your soils are fitted for tree growth, as well as grain. This is a fact not generally understood in the East, where I live, where the conviction prevails that no land is desirable unless trees can be made to grow about the home and on the farm. I am glad to learn my mistake; raising grain and trees will give you more of our restless people who leave the East for better openings in the West. Your forestry exhibit here will dispel many false notions about your State—for I perceive it can be easily made the land of homes."

NO SCHOOL OF FORESTRY ON THE WESTERN CONTINENT EXCEPT IN NORTH DAKOTA.

Dr. N. H. Egleston, a veteran forester, and long connected with the forestry division of the National Agricultural Department, furnishes me the following important letter:

WASHINGTON, D. C., Nov. 7th, 1894.

W. W. Barrett, Esq.:

DEAR SIR:—Your letter of Oct. 30 came in due season, and I reply as soon as possible in regard to the matter of Forest schools.

You are right in your supposition that there are none in our country, and none, so far as I know, on this continent. General Andrews, of St. Paul, endeavored several years ago, as you probably know, to get a grant of public lands for the purpose of establishing at least one such school. But he was not successful.

In regard to those in the eastern world, you will find in the annual report of our Forestry division, just out, and a copy of which has been sent to you, on page 360, the statistics of a few in Germany, Austria and Switzerland.

In addition to the primary or high school of Forestry at Vienna there are three secondary schools in Austria-Hungary, viz.: At Weisswasser in Bohemia; Eulenberg in Moravia; Lemberg in Galicia. There are two lower schools also at Aggsback, near Melk, Lower Austria, and at Wildalpen in Styria; also a school of Agriculture and Forestry at Kreutz in Croatia, and a Mining and Forest academy at Schemnitz.

There is a school, a very important one, at Nancy, in France, and one called the School of Forest Guards, at Barres.

There is one at Vallombrosa, in Italy; a School of Forest Engineers near Madrid, Spain, and a General Institute of Agriculture at Lisbon, Portugal. There is one at Copenhagen, Denmark, an Agricultural and Forestal academy at Moscow, an Agronomic Institute at St. Petersburg, and Forest schools at Lisino and at New Alexandria, Poland. There is a school at Evois in Finland also.

There is a Royal Forest institute at Stockholm and minor schools in other parts of Sweden, viz.: At Sillre, Tierps, Ombergs, Hunnenbergs, Boda, Danielslund and Skogshall.

There is one, recently established, at Cooper's Hill, near London, and in Asia, one at the university of Tokio, Japan, and one at Dehra Dun in India.

This completes the list as far as I am informed. I hope this may be of service to you. I write in great haste, and can only add that we need one or more good forest schools.

Yours sincerely,
N. H. EGLESTON.

FORESTRY SCHOOLS IN THE OLD WORLD.

In order to give needed light upon the question of forestry schools in the old world and what they teach, etc., I give below some extracts from the last report of Prof. B. E. Fernow, chief of the forestry division.

FORESTRY EDUCATION AND FORESTRY LITERATURE.

To be sure, the highly elaborate system of forest administration and forest management here outlined could not be developed or maintained without a special high grade education of those who direct the work. This education is provided for in the most ample manner, and consists not only in theoretical studies at schools, academies, and universities, but also in practical studies in the forest itself under the guidance of competent and experienced forest managers.

The course which applicants for positions in the higher administrative forestry service are expected to follow, with more or less modification in the different states, may be briefly outlined here:

After promotion from college the student goes into the woods for a short period (one-half to one year) to acquaint himself, under the guidance of a district manager, with the general features of the business he proposes to engage in, and thereby tests his probable fitness for it. He then visits for two and one-half or three years a forestry school (called academy when by itself, when at a university it is connected with the "faculty" for national economy), where theoretical studies with demonstrations in the forest are pursued.

After examination and promotion the applicant is bound at his own expense to occupy himself for two years at least in studying the practice in various districts, changing from place to place. If occupation can be found for him he is employed at small daily wages on some scientific or administrative work, always keeping an official diary of his doings and observations, certified to by the district manager with whom he stays, and which forms part of his final examination. For nine months during this time he must continuously perform all the duties of a lower official—a ranger—

for a whole or part of a range, and sometimes, also, for a given time, certain functions of a district manager. Then, after two years of law studies at a university, he enters into a close and difficult examination for a position as district manager, lasting 8 to 10 days. By passing this he is placed on the list of eligibles, and has thereby secured a right, enforcible in the courts if need be, to a position when a vacancy arises and his name is reached in the order of the list. This, in Prussia, may now be within 8 or 10 years after listing. During the interval he may be, and mostly is, employed on daily wages in various sorts of scientific and administrative work, such as revising and making new valuations, laying out roads, acting as tutor at the academies, or as assistant to district managers, or else taking the place of a manager temporarily, etc.

The higher administrative offices are filled by selections from the managers, length of service counting only when special fitness for the kind of work required accompanies it; so that, as in the army, the highest officer has been through all the grades below. and is conversant with every detail of the service. The pay is small, graded in each kind of position, according to length of service, and somewhat according to cost of living in different places, The honor of the position, to which usually other honors are added, its permanency, and the assurance of a pension, graded according to length of service, in case of disability or age, make up for small salaries. The salaries, subject to change from time to time, without adding the value of perquisites like houses, farm lands, etc., range about as follows in Prussia:

1 director (Oberlandforstmeister)		$3,600
4 forest councilors (Landforstmeister)	$1,800 to	2,400
33 chief inspectors (Oberforstmeister) (with additions for house and traveling up to $1,100)	1,050 to	1,500
89 inspectors (Forstmeister) (with additions for house and traveling up to $1,100)	900 to	1,500
679 district managers (Oberfoerster) (with additions up to $825 and house and field)	500 to	900
3,390 rangers (Foerster) (with house and addition up to $110)	260 to	360
349 guards (Waldwaeter)	100 to	200

The rangers (Foerster) follow different courses of instruction, part of which they receive in subordinate positions under district managers; while serving in the army in special battalions (chasseurs) they receive also theoretical instruction, which is supplemented in special schools. When finally promoted to the responsible position of rangers, in which much discretion and latitude are given them, their pay amounts to from $260 to $360, with a house and field, with the assurance of pension on withdrawal.

It was the privilege of the writer to visit nearly every higher forestry school in Germany, as well as that at Zurich, Switzerland, and to secure some material which should aid in completing the exhibit and bring the existence and work of the institution to the attention of our public.

In addition to materials contributed, which have been mentioned before, the following served more specially the latter purpose:

Eberswalde: Water-color painting commemorating the 50-year jubilee of the institution in 1880; portrait of the director, Dr. Dankelman; photographs of the academy building, old and new; samples of work of students in manuscript (four volumes); catalogues, plans of instruction, etc.; literature of professors.

Munden: Photographs of building and surroundings; map of city forest; guide and map to surrounding forests, used for instruction.

Tharandt: Photographs of buildings and surroundings; portrait of the director, Dr. Fr. Judeich; plan of instruction; map of surrounding forests, used for instruction.

Eisenach: Photographs of surroundings; photographs of professors; map of Thuringian mountains; three German eagles; pair of mountain cocks (Auerhahn and Birkhahn.

Tubingen: Map and guide to surrounding forests, used for instruction; literature of professors.

Giessen: Guide to experimental garden.

Munich: Literature of professors.

Zurich: A comprehensive collection of various materials specially prepared by Dr. Anton Buhler, the competent occupant of the chair of forestry, and director of the Forest Experiment station, especially charts illustrating experiments in thinning and forest meteorological observations; descriptions of methods of reforesting denuded mountain slopes; plans of forest garden experiments, etc. There was also exhibited by various plans and photographs methods and results of the model forest administration of the city forest of Zurich, under the competent manager, Forstmeister Meister.

This opportunity was also used to form an opinion as to which of the eight institutions visited would serve best the purpose of giving American students of forestry that knowledge which they can acquire only in a country where forestry has been practiced and object lessons are to be had, and where the principles underlying forest crop production, or forest culture have been fully developed.

While every one of the institutions has some special points to recommend it, be it due to its location, or to the personnel of its faculty, or to its methods of organization, I have come to the conclusion, that all points of advantage in the institutions considered, together with the objects and nature of students from the United States, the choice would be between Munich and Zurich, or part of the time at each, with a short visit to either Eisenach, Tharandt, Munden or Eberswalde.

The following table gives information regarding these forestry schools:

HIGHER FORESTRY SCHOOLS IN GERMANY FOR THE EDUCATION OF FOREST MANAGERS.

[Austria and Switzerland included.]

Name of Place.	State.	When Founded.	Length of Course (Years.)	Instructors of Forestry Branches Proper.	Total Number of Instructors.	Average Attendance of Forestry Students.
At Universities:						
Giessen	Hesse	1825	3	3	*	40- 50
Tubingen	Wertemberg	1818	†	3	*	50- 60
Munich	Bavaria	1878	†	8	*18	90-100
At polytechnicum:						
Karlisruhe	Baden	1832	3	2	19	15- 30
Zurich	Switzerland	1855	3	3	*20	15- 30
Vienna	Austria	1875	3	6	43	130-140
Separate academies:						
Aschaffenburg	Barvaria	1807	2	2	9	90-100
Tharandt	Saxony	1811	2½	3	10	100-135
Eisenach	Saxe Weimar	1830	2	3	8	65- 75
Eberswalde	Prussia	1831	2½	6	14	140-150
Munden	Prussia	1868	2½	5	13	40- 60

*The entire corps of professors of the University. In Munich 18 professors are engaged in lecturing on subjects which concern forestry students; in Zurich, 20 professors. In Munich all studies can be followed in any year, as the students may select. The attendance varies of course, widely in different years, having been as high as 216 in Eberswalde and 120 in Munich. The above figures are for 1885-'86.

†Not prescribed.

The following table will serve to give an idea of what instruction is to be had at these institutions:

PLAN OF STUDIES AT FOREST ACADEMY EBERSWALDE.

Subjects of Instruction.	Whole Number of Hours.
FUNDAMENTAL SCIENCES.	
Natural Sciences.	
General and theoretic chemistry	32
Special inorganic and organic chemistry applied	80
Physics and meteorology	80
Mineralogy and geognosy	60
Definition of minerals and rocks	20
Reviews for organic natural sciences	16
Botany in general and forest botony in particular	64
Anatomy of plants, vegetable physiology and pathology	60
Microscopy	20
Botanical reviews	20
Botanical excursions, each 2½ hours	80
General zoology	16
Vertebrates	80
Invertebrates, with special reference to forest insects	80
Zoological preparations	16
Zoological reviews	20
Zoological excursions, each 3 hours	96
Total natural sciences	840
Mathematics.	
Geodesy	72
Interest and rent account	20
Wood-measuring	20
Mathematical reviews and exercises	56
Surveying and leveling exercises, each 4 hours	192
Plan-drawing exercises, 2½ hours	80
Total mathematics	440
Economic Sciences.	
Public economy and finances	48
Total sum of hours for fundamental sciences	1,328

Subjects of Instruction.	Whole Number of Hours.
PRINCIPAL SCIENCES.	
Cultivation of forests	80
Forest implements	20
Geographical forest botany	48
Protection of forests	32
Forest usufruct and technology	80
Forest surveying	20
Appraising forests	80
Calculation of the value of forests and forest statistics	32
Administration of forest and hunting	48
Redemption of rights of usage	32
Forest history	40
Forest statistics	20
Review of various forest matters	56
Examinations	40
Forest excursions, each 4 hours	352
Total	980
SECONDARY SCIENCES.	
Jurisprudence.	
Civil law	72
Criminal law	32
Civil and criminal law suits and constitutional rights	40
Jurisprudence	36
Total	180
Construction of roads	32
Hunting	32
Shooting exercises, 2 hours each	96
Total sum of hours for secondary sciences	340
Grand total	2,648

	Per Cent.
Fundamental sciences	50
Principal sciences	37
Secondary sciences	13

Average per instruction week (21 weeks in winter; 17 during summer; 2 winter courses, 3 summer courses):

$$\frac{2648}{93}=28.5 \text{ hours, or per day, } 4.9 \text{ hours.}$$

LITERATURE.

In addition to the live teachings, which an able corps of professors impart at these institutions and that which competent managers are ready to impart to the young students in the forest itself, a large number of weekly, monthly, quarterly, and annual journals and publications are keeping the foresters and forestry students *au courant* with the progress of forestry science and forestry technique. Adding the publications of this nature which appear in Austria and Switzerland in the German language, and which have their constituency in Germany as well, we can make the following respectable list, not counting the journals of the lumber trade and other related publications. Those marked with an asterisk (*) are to be found in the library of the division of forestry; those marked (†) are considered the best or are most comprehensive; those marked (?) have been discontinued.

GERMAN FORESTRY PERIODICALS.

Name of Publication.	Published at.	Issued.	Estab lish'd
Allgemeine Forst-u. Jagdzeitung * †	Frankfurt-on-the-Main	Monthly	1824
Aus dem Walde	Hanover	Irregularly	1865
Aus dem Walde	Frankfurt-on-the-Main	Weekly	(?)
Deutsche Forst-u. Jagdzeitung	....do	Semi m'thly	(?)
Forstliche Blaetter	Berlin	Monthly	1863
Forstlich-naturwissenschaftliche Zeitschrift * †	Munich	...do	1892
Forstwissenschaftliches Centralblatt * †	Berlin	...do	1856
Jahresbericht des schlesischen Forstvereins	Breslau	Annually	1841
Jahresbericht der preussischen F. u. J. Gesetzbegung	Berlin	Annually	1868
Land-u. Forst-wirthschaftliche Zeitschrift	Vienna	Quarterly	1886
Muendener forstliche Hefte *	Berlin	Irregularly	1892
Oesterreichische Forst zeitung *	Vienna	Weekly	1882
Der praktische Forstwirt fuer die Schweiz	Davos	(?)	(?)
Schweizer Zeitschrift fuer Forstwesen	Zurich	Quarterly	(?)
Tharandter forstliches Jahrbuch *	Dresden	Annually	1850
Verhandlungen der Forstvereine	Various	...do	....
Bericht ueber die Versammlung deutscher Forstmaenner	....do	Annually	....
Zeitschrift fuer Forst-u. Jagdwesen * †	Berlin	Monthly	1869
Zentralblatt fuer das gesammte Forstwesen * †	Vienna	....do	1875
Zeitschrift der deutschen Forstbeamten	(?)	(?)	(?)

Should the reader wish to collect a library of the most modern thought on all or any subject pertaining to forestry in Germany, the list of books found at the Exposition should satisfy him, for although the books exhibited do not, by any means, include even all the best or most comprehensive or needful literature, they leave no subject untouched.

PUBLICATIONS OF PROFESSORS AT THE UNIVERSITY OF MUNICH AND OF OTHER AUTHORS.

[Faculty of Political Economy and Forestry.]

Author.	No.	Subject.
Prof. Dr. Karl Gayer	1	Sylviculture.
	2	Forest Utilization.
	3	The Mixed Forest.
Prof. Dr. F. V. Baur	4	Wood Measuring.
	5	Geodesy.
	6	Investigations Into Actual Mass and Weight of Cordwood and Bark.
	7	The Spruce; Its Yield, Accretion and Shape.

PUBLICATIONS OF PROFESSORS AT THE UNIVERSITY OF MUNICH AND OF OTHER AUTHHRS.—*Continued.*

Author.	No.	Subject.
Prof. Dr. F. V. Baur....	8	The Beech; Its Yield, Accretion [and Shape.
	9	Yield-tables of Spruce.
	10	Forest Valuation.
	11	Damage Awards to be Given in Forest Cessions.
	12	Academy or University?
	13	Forstliches Centralblatt (Forestry Journal).
Prof. Dr. R. Weber......	14	Forest Experiment Stations.
Prof. Dr. H. Mayr.......	15	Forest Regulation.
	16	The Forests of North America.
	17	From the Forests of Japan.
Prof. Dr. R. Hartig	18	Monograph on the Abietinæ of Japan.
	19	The Decay of Wood.
	20	Investigation Into Growth and Yield of Beech, Spruce, Pine, Fir, etc.
	21	Profitableness of Management for Timber in Spruce, and of Management for Firewood in Beech.
	22	Important Diseases of Forest Trees.
	23	Diseases of Trees.
	24	Investigations from the Forest Botanical Institute.
	25	The Wood of Conifers.
	26	The Wood of the Beech (Hartig and Weber).
Prof. Dr. R. Hartig.....	27	Anatomical Distinction of Woods.
	28	The True Rot *(Merulio lacrimans.)*
	29	Anatomy and Physiology of Plants.
Dr. K. V. Tubeuf........	30	Contributions Toward Knowledge of Diseases of Trees.
	31	Seeds, Fruits, and Seedlings of Forest Trees.
	32	Forest Natural History Journal.
	33	Seedlings of Abietinæ.
	34	Curcubitaria Laburni.
	35	Formation of Heart in Trees.
	36	Annual Botanical Reports.
Dr. Aug. Pauly.........	37	Bark Beetle Studies.
Dr. E. Ebermayer......	38	Hygienic Significance of Forests.
	39	Physics of the Soil.
	40	Composition & Value of Forest Litter
	41	Physiological Chemistry of Plants.
	42	Physical Effects of Forests.
	43	Properties of Forest Air.
	44	Lightning and Hail in the State Forests of Bavaria.
Dr. J. Lehr and T. Lorey	45	Allgemeine Forst u. Jagdzeitung (Forestry Journal).
Dr. T. Lorey............	46	Handbook of the Entire Knowledge of Forestry.
Dr. H. Fuerst..........	47	Forestry Dictionary.
Dr. F. Judeich..........	48	Tharandter Forestry Annual (Journal)

FORESTRY ASSOCIATIONS.

Forestry associations thrive better in Germany than in the United States and are of a different character; they are associations of foresters, who practice what they preach. There is no more need of a propaganda for forestry than there would be here for agriculture, and the discussions, therefore, are moving in technical, scientific and economic directions. Besides some 30 or 40 larger and smaller local associations there is held every year a forestry congress, at which the leading foresters discuss important questions of the day.

FOREST EXPERIMENT STATIONS.

In addition to all these means of education and advancement of forestry science, there has been developed in the last 20 years a new and most important factor in the shape of forest experiment stations, which are mostly connected with the forestry schools. If forestry had a strong and well-supported constituency before, this additional force has imparted new impulses in every direction.

The first incentive for the establishment of these stations came from the recognition that the study of forest influences upon climate could be carried on only with the aid of long-continued observations at certain stations. Accordingly, during the years 1862 to 1867, forest meteorological stations were instituted in Bavaria, which, under the efficient direction of the well-known and eminent Dr. Ebermayer, for the first time attempted to solve these and other climatic questions on a scientific basis. The results of these and other observations have been fully discussed in Bulletin 7 of this division, published during this year.

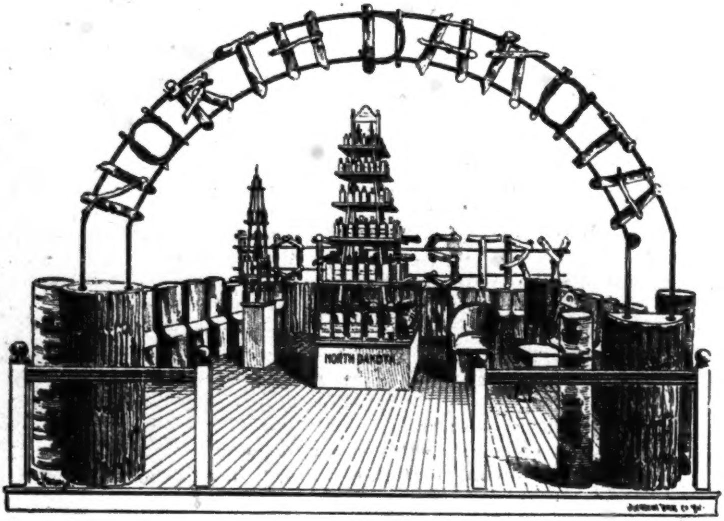
We were privileged to exhibit some of the apparatus devised by Dr. Ebermayer, and some of his results, namely:

Set of soil thermometers,
Rain gauge combined with evaporimeter,
Two charts showing relation of rainfall and evaporation within and without forests.

FORESTRY EXPERIMENT STATIONS IN THE UNITED STATES.

There are numerous Forestry Experiment stations in the United States, and they have all proven very serviceable. Those of California are highly appreciated by that state.

There is a State Forestry Experiment station in Australia. It is very extensive, raising millions of trees.


NORTH DAKOTA
FORESTRY
NORTH DAKOTA

THE SYLVATON SYSTEM.

The enlistment of the children of the State in the principles and developments of forestry and irrigation, is fraught with inestimable blessings to the nation and the people.

THE SYLVATON IDEA—ENLISTING THE CHILDREN OF NORTH DAKOTA IN THE SUBJECT OF FORESTRY.

Under the management of W. A. Davis and the writer, on Nov. 9, 1894, a School District Sylvaton Society was organized in connection with the Church's Ferry, Ramsey county, N. D., village school. A most attractive Sylvaton tower, made in imitation of the World's Columbian Fair Sylvaton tower, was presented to the society by the writer, together with a collection of choice forest seeds, nuts, acorns and native wild fruit, woods, minerals, etc. This valuable cabinet gave much pleasure to the children and the visitors. The occasion was a winter Sylvaton celebration. The exercises on the part of the children related mostly to the subject of forestry and were all of a highly entertaining nature.

In harmony with the occasion, I deemed it best to outline the Sylvaton system, which is presented below:

My Young Sylvaton Friends:—This celebration calls for some statements from your speaker explaining, to some extent, the Sylvaton idea of North Dakota, or the enlistment of the school children of the State in the great question of forestry and kindred subjects:

EARLY PIONEER WORK.

It will be remembered by the old pioneers of our State that for many years I advocated various ideas in regard to the questions of forestry, irrigation, meteorology, etc., and how to populize and make practical these great economic reforms for the benefit of our State and its intelligent citizens. The various phases of these problems were presented to the public in numerous ways and received the unlimited endorsement, because of their practical merits, of all classes and the legislators, until numerous important and wholesome laws were passed covering all three of these great problems, including the act creating the office of State Superintendent of Irrigation and Forestry, whereby we of North Dakota are placed on an equal footing with other advanced states having similar departments.

YOUNG FORESTERS.

One of the leading ideas that entered into my system, in the direction of forestry in particular, was to enlist the children of the State in this pleasing and important problem and thus prepare the way for a future generation of earnest, intelligent and practical foresters. This must, as a sequence, be the result, if this reform is properly managed, for it should be remembered that as the "twig is bent the tree is inclined." To the most observant it is clearly plain, that the loves, views and habits of the coming men and women will depend largely upon the training and influences of their early days. And in order to bring the young into this good work, it becomes apparent a state forestal association should be organized.

NAMING THE NEW MOVEMENT.

In the last part of the spring of 1892 I was at Joseph Greenwood's, nearly four miles to the south of Grand Forks, where the sturdy and intelligent farmer was employed by myself in getting out the North Dakota tree trunks for the colonnade of the renowned forestry building of the Great World's Fair. The timber lot—nature's own beauty spot—consisted of seventy-five acres of fine trees. There, at the model home of the yeoman, I gave the name cf Sylvaton, from the word sylva, which signifies wood or forest, to the new movement, and the beautiful grove I named Sylvaton Park.

PLEASANT AND INSTRUCTIVE SCHOOL EXCURSIONS.

Working out the idea of educating the children as well as the adults in sylva culture, I organized excursions from the schools of our State into the native woods, where, with their teachers, great zeal and much pleasure was manifested in the collection of forest fruit as a part of the North Dakota forestry exhibition at the great World's Columbian Fair, held in Chicago, Ill., in 1893. Through those school excursions and gatherings made by school representative collectors, many counties and schools made direct contributions. But the idea was extended further in that, by selecting certain representative State collectors, including myself, who procured a large proportion of the forest fruit specimens, every county and every school of every kind and nature of our State was represented in the renowned historical display known as

THE NORTH DAKOTA WORLD'S FAIR SYLVATON EXHIBIT.

Prominent amongst the schools that made direct collections, may be mentioned in way of pleasant remembrances the following: The Minot city school, which with enthusiastic interest, went out in a body on a bright pleasant afternoon of an autumn day in 1892, under the supervision and presence of Prof. Arnold and his assistants, and gathered in the native woods on the Mouse river, a large and valued quantity of acorns, forest seeds and other specimens for the great World's Columbian Fair. That same fall and year (1892) occurred the Grand Forks excursion, caught in a fleecy snow storm before the close of the exercises. Delegates consisting of boys and girls and young gentlemen and young ladies, one of each sex, from each of the three Grand Forks city schools, the Catholic seminary, the Grank Forks college and State University, were commissioned to make collections in the name of these schools. In the charming Sylvaton Park, these intelligent and pleased excursionists secured many choice and valuable specimens of forest fruit for the Sylvaton Exhibit that has since won such high and merited distinction.

One of the most pleasant excursions made that fall (1892) was under the management of Miss Bee Allen, of the Blackburn district, near Grand Forks. This good teacher, rambling through the Sylvaton Park with her entire school, each member of which evinced the fullest delight in the pleasant exercises on that clear, mild, autumn day, procured many varieties and large amounts of acorns, forest seeds, nuts and wild native fruit, which were finely displayed as an important part of the North Dakota Sylvaton exhibit. The delegate collectors, William and Betsy Sjoberg, commissioned and instructed as to duty by their wise teacher, Miss Lizzie Schultz, and assisted by the children of Mr. H. E. Hoadley, gleaned in the mild sunlight on Nov. 10, 1892, near the beautiful "Forest Home" on Graham's Island, in the Devils lake woods, many of the most attractive specimens seen in our State forestal exhibit at the World's Fair.

And I will here add: These children of the Sjoberg and the Hoadley families, were some of the most active and successful "representative forest seed collectors." Their specimens were secured in the name of all the schools of all kinds of the State of North Dakota. The amount which they gathered was large, the varieties many and the quality superior.

The collections made in the wild forests of the "Picture Park" by the children of the W. H. Kirk and A. J. Hart families, in Bottineau county, and the Thomas Hasketh family, near Rolla, were amongst the most choice of the exhibit.

THE ADMIRATION OF ALL.

This, the now renowned Sylvaton Exhibit, in connection with our State wood display in the vast forestry building at the World's Columbian Fair, was one of the most notable features of the entire collective exhibitions of the forestal productions from all parts of the peopled globe, and it became the admiration of the thousands of the denizens thereof who daily thronged, studied and enjoyed the fascination of that beautiful, massive structure, made entirely of woods, the first and only one of the kind in the history of the human race.

ART'S BEAUTEOUS DISPLAY.

Seeking object lessons to instruct the mind and gratify the heart, the young and old, the unlettered and the learned and wise, the thinkers, the authors, the philosophers and the scientists of all climes and nations sought from hour to hour the North Dakota pavilion, and sitting in the "Governor Burke Rustic Oak Chair," carved out of a section of one of our noble native oaks, being the only chair of like make in the entire fair, each one and all enjoyed, admired and praised our forestry display, especially the matchless Sylvaton Exhibit, combining instruction and beauty, like a picture, art designed, from the skillful hands and thoughtful brains of the young of our progressive State.

"THE BEST FEATURE OF THE WHOLE EXHIBIT."

It was my privilege to be present when the inspecting judge made an examination of the North Dakota forestry exhibit, and I gave that gentleman many facts in regard to the matter of our forestal development. This inspector, Hon. Robert N. Hudson, was well fitted for his duties, being the superintendent of the New South Wales Exhibit at the World's Fair. He was well pleased with our woods and the manner of their display. But the Sylvaton Exhibit received his special attention, and it made a most favorable impression upon his mind. And, learning from me that many of those forest specimens were collected under my supervision by the school children of our commonwealth, through an organization known as the Sylvatons, or young students of forestry, the intelligent and courteous inspector said to me, with no small amount of pleasure and earnestness: "THIS SYLVATON IDEA, OR THE INTERESTING THE CHILDREN OF THE STATE IN THE MATTER OF FORESTRY IS THE BEST FEATURE OF THE WHOLE EXHIBIT." And although the award came to myself as the originator of the system and the exhibit, nevertheless the Sylvaton Idea, or the engagement of the children of the State in sylvaculture, seemed so meritorious that the award was granted on that idea or principle, as may be learned by any one by an examination of the wording of the diploma. Thus, my young foresters, you can perceive how highly the school children of our commonwealth have been honored for their thoughtful and praiseworthy co-operative work, in which, it is most pleasant to remember, a number of the members of this school of Church's Ferry took an active and most important part. These tokens of merit are the more significant from the fact that no other school or other children of any other state or nation of our fair, green earth received similar awards or awards of any kind, as far as I can learn, for exhibits of forest fruit.

NORTH DAKOTA THE SYLVATON STATE OF THE UNION.

The Sylvaton Idea, or the practical employment of the children of the state or nation in the paramount question of forestry, had its origin in and belongs to our own loved commonwealth, and the World's Fair intelligent officials so far recognized the great significance and practical advantage of this comprehensive and benecial system that they deemed it worthy of the highest token of appreciation and hence most willingly bestowed the award. Therefore the people of our union and nations at large must, with respect, acknowledge that North Dakota is, and of a right should be, the Sylvaton State of the union.

THE EXCELLENCE OF THE SYLVATON EXHIBIT.

Except that of France, which nation received no award on its superb seed and nut collection from its forests, no exhibit of forest fruitage at the mighty World's Fair, could in any way compare with the excellence of the Sylvaton tower and its unique display of specimens, consisting of forty to fifty varieties of forest seeds, acorns, nuts and native wild fruit, in 350 to 400 glass vessels, urns, globes and vessels of all forms and designs, wherein the samples of different outlines, sizes and colors gave the "child thought" in charming fascination, together with scientific order and arrangement—nature's own beauteous formations in holding the vital life germs of the forests and fruits of the prolific earth.

THE PRACTICAL FEATURE.

The Sylvaton Exhibit was one of beauty, but it had a practical side, like the exhibit of our wheat and corn at the Columbian Fair, for it represented great and important products of our State, all of much value as a source of income, and as furnishing elements in the way of food favorable to the life and support of man and beast. The great value of these can be fully understood when it is remembered they, to-wit, forest seeds, acorns, nuts and wild fruit, would amount, if gathered, to many car loads, and would make long trains of cars, each successive year, though the crop varies from season to season, as with the fruit from cultivated trees. Even our wild fruit alone would fill numerous vessels each glad harvest time. The principal varieties consist of juneberry, haw, choke cherry, red cherry, black cherry, sand cherry, the various kinds of plums, high-bush cranberries, buffalo berry, wild rice, red and black cap raspberry, dewberry, strawberry and wild grapes, in all constituting 20 different kinds. Hence it can be readily seen how largely important it became to have a display of the forest fruits of our State at the great World's Fair.

ORGANIZATION.

The State Sylvaton society has been organized. Its officers consist of a president, vice-president, secretary, treasurer, and an executive committee and the State Superintendent of Irrigation and Forestry is ex-officio chief forester, and the state superintendent of public instruction is ex-officio educational forester. Any person may become a member of this society by signing the constitution and paying the required fee (no fee is required at present). Any person may become an honorary member by a majority vote of the society.

OBJECTS OF THE STATE SYLVATON SOCIETY.

The objects of the State Sylvaton society shall be to unite the educational forces of the State by means of like local societies, represented in this body for forestry and co-related work, as set forth in the objects defined by the local Sylvaton societies, in their practical application to the betterment of climatic, meteorological, agricultural and horticultural conditions, wherein are involved the best interest of the State and the people.

AWARDS OF MERIT.

The State Sylvaton society, through its president, secretary and chief forester, will grant awards of merit or diplomas, to any Sylvaton, or Society of Sylvatons, in the State, or elsewhere, that practically demonstrates superior proficiency in tree or forest culture, or in best collection of forest products, or best original essay on forestry, botany, irrigation, meteorology, or other correlative subjects.

OFFICERS OF THE STATE SYLVATON SOCIETY.

Chief Forester—W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.

Educational Forester—Mrs. Laura J. Eisenhuth, state superintendent of public instruction, Bismarck, N. D.

President—W. C. Baker, editor of the North Dakota Farmer, Grand Forks, N. D.

Vice-President—L. B. Fancher, county superintendent of Ramsey county schools, Devils Lake, N. D.

Secretary—Miss Emma C. Craus, of the State University, Grand Forks, N. D.

Treasurer—L. C. Scott, Lakota, N. D.

Executive Committee—H. D. Orvis, Churchs Ferry, N. D.; Miss Hannah J. Holton, Lakota, N. D.; Bernt Anderson, Church's Ferry, N. D.

Honorary Members—Grover Cleveland, president of the United States; Hon. H. C. Hansbrough, United States senator; Hon. W. N. Roach, United States senator; Hon. M. N. Johnson, representative to congress; Hon. E. C. D. Shortridge, governor of North Dakota; Hon. Roger Allin, governor-elect of North Dakota; all the State officers of North Dakota; all members of the legislative assembly of North Dakota; Hon. J. Sterling Morton, originator of Arbor Day; Prof. B. E. Fernow, chief of the United States forestry division, agricultural department, Washington, D.

C.; Prof. H. B. Ayers, Forester, N. J.; Hon. J. O. Barrett; secretary Minnesota Forestry Association, Brown's Valley, Minn.

SCHOOL DISTRICT SYLVATON SOCIETIES.

There may be local or school district Sylvaton societies in connection with all schools of all grades and kinds of the State. Any person under 21 years of age may become a member by signing the constitution and paying the required fee (no fee is required at present). Any person over 21 years of age may become an honorary member by a majority vote of the society. Its officers shall consist of the same as those of the State Sylvaton society.

HOME SYLVATON SOCIETIES.

There may be County and Home Sylvaton societies, both having the same number of officers and same objects as the school district societies, except the home society shall give more attention to forestry as it appertains to the home place. The school district, county and home Sylvaton societies shall act with the State Sylvaton society.

STATE SYLVATON ORGANIZATION.

ARTICLE I.

Section 1.—The officers of the State Sylvaton society shall consist of a president, vice-president, secretary, treasurer, an executive committee of three and a vice-president in each county. And the State Superintendent of Irrigation and Forestry, or where there is no such State officer, the secretary of the State Forestry association, or commissioner of forestry shall be *ex officio* State chief forester, and the state superintendent of public instruction shall be *ex officio*, the state educational forester. Said officers shall be elected by a majority ballot of the delegates at each annual convention. The place and time for holding the first annual convention shall be fixed by the executive committee, *pro tem*, and each local society, whether home (consisting of a neighborhood of homes) school district or county, shall be entitled to one delegate. The executive committee, appointed by a preliminary meeting, shall select said officers, *pro tem*, holding their office until their successors are elected at the first regular convention, when by a two-thirds vote this may be altered or amended.

OBJECTS OF THE STATE ORGANIZATION.

Section 2.—The objects of the State Sylvaton society shall be to unite the educational forces of the State by means of like local societies, represented in this body, for forestry and kindred work, and their practical application to the betterment of climatic, meteorological, agricultural and horticultural conditions, wherein are involved the best interests of the community.

AWARDS OF MERIT.

Section 3.—The State Sylvaton society may grant awards of merit or diplomas to any Sylvaton, or society of Sylvatons, in the State or elsewhere, that practically demonstrates superior proficiency in tree or forest culture, or in best collection of forest products, or best original essay on forestry, botany, irrigation, meteorology, or other correlative subject; and such awards shall be signed, under seal, by the president, secretary, and the State chief forester, and in some instances, as a work of the highest honor, also by the State educational forester.

DUTIES OF THE OFFICERS OF THE STATE SYLVATON SOCIETY.

Section 4.—The duties of the president or vice-president of the State Sylvaton society, shall be the same as those of any other ethical society, and said officers shall preside according to parliamentary rules.

And the president shall make an annual report, or oftener if deemed best, of the doings of the State and local Sylvaton societies to the State Chief Forester.

Section 5.—The secretary of the State Sylvaton society shall keep a record of its doings and report the same at the next meeting, and file all essays and other papers belonging to the society; attend to all correspondence and report the doings and progress of the society at the annual meeting of the same.

Section 6.—The duties of the treasurer of the State Sylvaton society shall be to collect and hold in trust all funds of the society, subject to its control, and shall pay out the same on orders drawn by the president and countersigned by the secretary, and shall make an annual report at the annual meeting of the society of receipts and disbursements and condition of the treasury.

Section 7.—The executive committee of the State Sylvaton society shall examine and audit the treasurer's accounts and reports, and attend to all other duties required by the society.

Section 8.—The State Chief Forester, acting in concert with the president, shall have a general oversight of the affairs of the State Sylvaton society, and he, and also the president of the society, shall make a report of its work and progress at its annual meeting. And the said State Chief Forester, and also the president, shall make an annual report of the operation and progress of the society to the State Educational Forester.

Section 9.—The State Educational Forester shall, at his or her own discretion, make such recommendations and reports to the governor of the State, the school officials and teachers, or to the people at large, as may be deemed desirable for the promotion of the objects of the Sylvatons, involving the best interests of the State.

Section 10.—Any person may become a member of the State Sylvaton society by signing the constitution and paying the required fee, and any person may become an honorary member by a majority vote of the society.

ART. II.—LOCAL SOCIETIES.

Section 1.—There may be a local Sylvaton society in any school district, or school or institution of learning of any kind within the State, and it shall have the right to regulate its own affairs in harmony with the constitution of the State Sylvaton society in this form:

The undersigned, members of school district (or home, county or other educational institutions), No.——, town———, county of———, State of———, hereby organize ourselves into a body corporate, to be known as the ——— School District Sylvaton society.

N. B.—In order to conform to the facts or circumstances, substitute home, county or higher educational institution in place of school district; illustration: The Anderson Home Sylvaton society; or the Forest Home Sylvaton society; the Ramsey County Sylvaton society; the State University Sylvaton society, etc.

Section 2.—Under the head of local societies there may be county and home Sylvaton societies, each having the same number of officers and same objects as the school district societies, except the home society shall give more attention to forestry as it appertains to the home place. The school district, county and home Sylvaton societies shall act in concert with the State Sylvaton society.

OFFICERS OF THE LOCAL SOCIETIES.

Section 3.—The officers of the Sylvaton society shall consist of a president, vice-president, secretary, treasurer and an executive committee of three, having duties the same as in Art. 1, Sec. 7, and they shall be elected annually by ballot.

Section 4.—The county vice-president of the State Sylvaton society shall be, *ex-officio*, the president of the county Sylvaton society whose duties shall be to establish local societies; to supervise and encourage the same, and make an annual report of the operation and progress of the county and other local societies to the president of the State Sylvaton society.

Section 5.—The duties of the president or the vice-president of the local Sylvaton society shall be the same as those of any other ethical society, and said officers shall preside strictly according to parliamentary rules.

And the president of the local Sylvaton society shall make an annual report, or oftener if deemed best, of the doings of said society to the president of the State Sylvaton society.

Section 6.—The secretary of the local Sylvaton society shall keep a faithful record of its doings and report the same at its next meeting, file all essays and valuable papers belonging to the society, attend to all correspondence and report the doings of the society at the annual meeting of the same. And he or she shall register the species and number of trees planted on Arbor Day under the management of the said local Sylvaton society, mentioning their localities, and shall report the same and the name of the person to whose care the plants are entrusted, and the number and species of trees and shrubs living at least one month before the next observance of Arbor Day, to the president of the State Sylvaton Society.

Section 7.—The duties of the treasurer of the local Sylvaton society shall be to collect and hold in trust all funds of the society, subject to its control, and shall pay out the same on orders drawn by the president and countersigned by the secretary, and shall make an annual report at the annual meeting of the society of receipts and disbursements and condition of the treasury.

Section 8.—The executive committee of the local Sylvaton society shall examine and audit the treasurer's accounts and reports, and attend to all other duties required by the society.

Section 9.—The local Sylvaton societies may annually hold delegate conventions in their special towns and counties, officered as herein designated, for the furtherance of these objects.

ART. III—OBJECTS OF THE LOCAL SOCIETIES DEFINED.

Section 1.—To faithfully perform all duties in relation to and required by the State Sylvaton society.

Section 2.—To make forestry a life study in intelligent, scientific and practical application and co-operate with the State and all other movements for forestal culture wherever the same may be needed for beneficial results.

Section 3.—To arrange for and properly observe Arbor Day by means of Sylvaton celebrations, involving, among other things in the exercises, the planting of trees, shrubs, vines and flowers and their dedication as memorials of important historical events, and of eminent and philanthropic persons.

Section 4.—To collect, label and exhibit specimens of woods, barks, leaves, twigs or branches, roots, flowers and fruit of plants, and all the indigenous flora of the State, together with geological and archæological specimens, for a school cabinet or museum of the same, and to procure exchanges with other societies, institutions and individuals wherever feasible.

Section 5.—To surround the home with trees and all desirable and attractive flora for the best influence upon the mind and heart.

Section 6.—To advocate and work for larger grounds for the school house, its proper fencing, a good supply of wholesome water and air, the planting and cultivation of trees, shrubs, vines and flowers, the final object being to convert the grounds into an *attractive school park*, that the environments may aid in the better development of character, and prove an ornament and credit to the State.

Section 7.—To encourage appropriate essay writings, discussions and lectures, and secure the general endorsement of the press, the church and other influential organizations, relative to forestry, irrigation, meteorology and kindred subjects for a more diffusive information upon their uses in the economy of nature and civilization.

Section 8.—To co-operate in every desirable way for the carrying out of the objects of a State School of Forestry.

Section 9.—To assist in furnishing specimens for the great forestal and irrigational museum, which, as object lessons, should be created in connection with the State School of Forestry.

Section 10.—To encourage irrigation in co-relation with tree culture.

Section 11.—To advocate and labor for the teaching of forestry by practice as well as theory, in all schools and institutions of learning of every kind and grade in the State.

Section 12.—To become acquainted with the science of botany for practical uses.

Section 13.—To advocate and strive for the creation of a healthy public sentiment and the enlistment of national and state legislation for the protection, cultivation and economization of the native woods and the domestic trees of the State, and the exclusion of fires therefrom, for domestic, manufacturing, commercial and all other material and beneficial uses.

Section 14.—To encourage the enlargement, as far as circumstances will allow, of the grounds and the creation of parks thereon, of not only the school house premises, but all cemeteries, "the home of the dead;" all churches, theaters, museums, public libraries, village, city, county, state, national and all other public buildings, and in addition to encourage home, county, village, city, state, national and educational parks, or sylvan retreats and forest reservations, state and national, the latter to be located mainly near the sources of the streams and rivers of the State for the conservation of the waters thereof; and also to encourage a more thorough planting of trees upon the farm, along the road side and the village and city streets and wherever desirable—all for the many practical advantages, æsthetic influences and blessings that may result therefrom.

Section 15.—To encourage and labor for the cultivation of choice and hardy varieties of apples and other well selected domestic, and also native wild fruits, nut trees and plants, adaptable to the climate; and floriculture for the home, and a more economic and æsthetic agriculture, better promoted by irrigation and forestry.

Section 16.—To encourage excursions into the woods or elsewhere, for the purpose of gathering suitable forestal, botanical, mineral and other desirable specimens for the school or other museum, and for the social and hygienic advantages resulting from such recreations and the study of the "Book of Nature."

Section 17.—To encourage and labor for the establishment throughout the State of public Sylvaton libraries, museums and reading rooms, where the Sylvaton exhibits may be displayed, and books, magazines and papers of a wholesome nature may be found for the entertainment, instruction and refinement of the community.

Section 18.—To encourage the creation of a national forestry department and a wise national management of forestry and irrigation.

Section 19.—To become acquainted with a knowledge of the birds of the State and their habits and usefulness, with a view to defend them against all robbery of their nests and all unkind treatment, so that they will delight to stay with and bless us with their melodies and their destruction of injurious insects; also to procure legislative enactments for their better protection.

Section 20.—To advocate, expound and demonstrate the absolute necessity of forestry and irrigation in their broadest and most comprehensive development throughout the State, the nation and the entire world for the proper balancing of the forces of nature, the improvement of climatic conditions and all the favorable benefits involved therein.

Section 21.—To advocate the principles of and render sympathetic aid to the American Forestry Association in its comprehensive work in behalf of forestry.

Section 22.—To encourage and earnestly labor in behalf of forestry, for its material benefits, refining influences and favorable environments, whereby, through natural causes, there comes a strengthening of the love of home, the spirit of patriotism and the philanthropic desire and purpose to aid and bless present and future generations.

Section 23.—To advocate and work for the extension of the Sylvaton Idea, or the enlistment of the children of the State in the question of forestry, to all states and nations of the earth that thus, in connection with other agencies, beneficent good and blessings may come to the human race.

ART. IV.—NO SALARIES.

Section 1.—No officer of State or local society shall receive pay for services, except bare cost for duties performed, and then only when approved by the executive board.

Section 2.—All moneys of this society shall be expended as voted for at any regular meeting, but in every instance for the sole benefit of this society.

ART. V.—REGULAR MEETINGS.

Section 1.—The meetings of the local Sylvaton society shall be held at such times and in such places as may be voted for, and their exercises shall consist of verbal or written reports of personal observations and experimentations along the lines herein mentioned; also appropriate lectures, essays, discussions, music and song.

ART. VI.—MEMBERSHIP.

Section 1.—Any person under 21 years of age may become a member of the local Sylvaton society by signing this constitution and paying the required fee; other persons over 21 may become honorary members by a majority vote of the society.

ART. VII.—AMENDMENTS AND BY-LAWS.

Section 1.—This constitution may be amended at any regular meeting, after one month's previous notice, by a two-thirds vote of the members, and by-laws instituted as may be deemed essential to order and success.

MUCH TO ENCOURAGE US.

The objects for which we, the Sylvatons of North Dakota, are enrolled are worthy, and they are deserving of our best thoughts, highest purposes and most conscientious and zealous efforts from day to day and from year to year. And there is much to encourage us in this good, grand and most worthy work, for we are engaged in those things that deeply concern the full development of the native elements and resources of our rich young State, and the present and future prosperity of our people. The questions that are before us, and the needful reforms which they involve are not only interesting and instructive, but if studied wisely and made practical by intelligent common sense action, the result must, as a legitimate result, conduce to the highest benefit, from all points of view to every state and nation of the civilized world, not only during the present time, but through the ages yet to come. Let us, as Sylvatons, think wisely, strive zealously and act judiciously, that the principles which we advocate may be fully understood, endorsed and made operative for enduring benefits to the denizens of our own State and the world at large. If as faithful votaries we are true to our profession, and all the great and mighty issues involved in forestry and kindred subjects, assisted by others striving for the same great and good purposes, we will in time revolutionize our State in the direction of most needful economic reforms of a practical nature, in that we, duly aided by others and making a judicious use of our waters, will cover our State with trees and forests, groves, parks, sylvan retreats, forest reservations and irrigation plants and developments on mounts and hills and plains, and give grateful shade and protection to the house, the barn, the farm, the school and all the public buildings and ways. Thus the northern blasts and the simoons of the south, and the blighting drouths, will be set at naught, the water conserved, precipitation increased, the climate improved, the land "re-Edenized" in beauty, pictured afar and near, and bounty given in munificence from the Great Bestower in form of grain and fruit from field, orchard, and the house garden, for the enrichment, peace and comfort of all who dwell in North Dakota.

THE HOME STATE OF THE WEST.

Then when this glad work shall be consummated in our own and the other states of the globe, the future historians will say: "The Sylvatons of North Dakota, the realm of verdure, beast, grain, fruit and tree, and a wise, good yeomanry, gave beauty to the earth, increase to the land, aid to the needy, comfort, contentment and happiness to all and honor and renown to the State and nation, and hence were practical benefactors of the great brotherhood of man."

EDUCATIONAL WORK—FORESTRY IN THE SYLVATON STATE—EARNEST COMMENDATION OF THE SYLATON SYSTEM FROM LEADING EDUCATORS OF THE STATE.

Many letters have reached this department endorsing the Sylvation Idea. This is most highly gratifying to the Sylvatons who, in the Columbian year, entered upon their work, having in view the forestation of our fair, promising State. Every word of cheer and commendation gives hope and courage, not only to the young people of our commonwealth, but to the officers of the new organization of foresters having in charge the great and good undertaking.

I herewith present with pleasure a few of the letters received from our intelligent educators and advocates of the reform, that the Sylvatons and their friends may learn how fully the principles and the system of the new forestal association are understood and endorsed by those best fitted to speak understandingly upon the great and all important matter.

A SCHOOL DISTRICT SYLVATON SOCIETY ORGANIZED AT LAKOTA.

On the morning of Dec. 10 the writer, aided by Prof. Clarkson A. Hall, the county superintendent of schools of Nelson county, W. T. Campbell, principal, and his able assistants, organized a school district Sylvaton society, in connection with the village school of Lakota, Nelson county. Six entertaining and instructive speeches were made by prominent persons of the community on the occasion, and the Sylvaton Idea was fully and most heartily endorsed. The deepest interest prevaded the school, particularly from the fact that these same scholars took an active part in the original movement, and collected some very fine specimens for the noted North Dakota Sylvaton exhibit at the World's Fair. Sixty pupils and the three teachers joined the association, and many of the leading citizens of that enterprising place were elected honorary members. A committee was appointed to prepare for a Sylvaton celebration on next Arbor Day. The plan is to have something truly worthy of the new Sylvaton system, and, as far as possible, it is proposed to not only engage all the schools of Nelson county in such celebrations, in each district, but also to encourage Sylvaton celebrations, on an extensive scale throughout the State, aiming to have not only literary exercises, but an increased study of the works of nature, and the planting of many forest trees, bushes, vines and flowers, and also apple trees, plum trees and all other kinds of fruit bearing trees and bushes, wild and domestic, adapted to our State and climate. The purpose is to plant these trees and bushes in school and church yards, the parks and cemeteries, and interesting the farmers, upon the farms and around the homes, at least, in the matter of planting upon the farms, and about the home places, as far as such celebrations will allow. It is trustingly believed, as the movement is a worthy one, it will be commended and aided by the educators and friends of forestal development on Arbor Day.

NUMEROUS OTHER ORGANIZATIONS.

Numerous other Sylvaton societies have also been organized in connection with schools of late, and in every instance much enthusiasm has been manifested by the organizers, and each society has commenced a museum as object lessons.

"THE WONDER WORKING WIZARD EXECUTION."

This letter comes from one of the most intelligent, zealous and eminently practical educators of our State. Professor Hall is doing great work, in taking wise and energetic action toward securing the fencing of all school grounds in every district in Nelson county.

LAKOTA, Nelson County, N. D., Dec. 9, 1894.

Hon. W. W. Barrett, Commissioner of Irrigation and Forestry:

MY DEAR SIR:—Your article in the Grand Forks Herald of Dec. 1, is of deepest interest to every North Dakotan. It treats of a subject which is of vital importance to the highest development of our State, in respect to the home and school environments. Left to nature, the battle between fire and water on these broad prairies will continue to terminate from year to year in favor of fire, and the forest growth will be held back. In regions of greater rainfall the water element prevails, and the forest towers skyward. But ally human intelligence and human activities to nature's rain supply here, and the garden, the shade tree, the beautiful groves and singing birds, and shrubs and flowers, orchards and small fruits bending to the fair hands of our boys and girls, all will become as common in our State of blue skies and sunny days, as they are in any latitude or clime. Someone asks, how do you know this; how dare you speak thus prophetic? I answer in the words of the trite legend, "seeing is believing," and what has been accomplished here and there in our State, and in this county, can be extended. During two years constantly visiting different sections of this county, I have carefully studied the condition of things, and the doings of our farmers. I have seen the children sitting under, or standing by, the currant and the berry bushes gathering the abundant fruit. I could tell you of scores of groves of luxuriantly growing trees, and I could point out the difference between those properly cared for and those left to fight for existence against adverse conditions. The loads of native plums put upon our markets last season proves this to be the natural home of this valuable fruit. It has been demonstrated that the apple of the harder kinds will flourish and be fruitful as far north as Manitoba.

Now, my dear commissioner, I have a great deal more that I would like to say to you on this most interesting and inexhaustible subject that lies so close to our material and ethical wants. But this letter must not be too long.

At our last institute we made a start along these lines. Since that date Lakota school grounds have been fenced and 200 box elder and cottonwood trees, about seven feet high, set out, the contractor warranting every tree to grow. Other districts are preparing to fence and be ready to set trees next Arbor Day. How would it do to prepare blanks pledging every school board to build fences and be ready to plant from 10 to 100 trees, with the assistance of the teachers and children, next Arbor Day? A thousand school houses could be supplied the same day as easily as one. No use to talk, no use to write, no use to indulge in word pictures, no use to decide unless we follow up with the wonder-working wizard, execution. I think that we are ready to join hands with you who have done so much in this good work, Commissioner Barrett; the field is white for the sickle, the iron is hot, we are all ready, the boys and girls, the teachers and school officers, and the great, generous, enterprising people back of us all. Let next Arbor Day in North Dakota be the banner Arbor Day of this republic. Let 50,000 pairs of ready hands as Sylvatons and friends carefully arrange the rootlets of 1,000,000 trees and plants on that eventful day, and then 50,000 school children can get closer to the great loving heart of old mother nature, watching daily the power of the sunshine, the rains, the rich earth elements as they go on tree building. The cumulative growth of all that is beneficent in this for the child and for the State will repay many times over every recurring year, all the outlay.

With deepest respect, most truly yours,

CLARKSON A. HALL,
Superintendent Schools Nelson County.

"BASED UPON PRACTICAL COMMON SENSE GROUND."—A FARMER'S VIEW.

COULEE, Ramsey County, N. D., Dec. 15, 1894.

Hon. W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—Your Sylvaton Idea has true merit, and it is based upon practical, common sense ground, because, as I look at the matter, if forestry is taught wisely and made entertaining to the school children of North Dakota, when they become of age they will have such knowledge and love of the art that all such who may become cultivators will, in a majority of cases, be earnest foresters, or as you put it, good Sylvatons, and then plenty of trees will beautify all parts of our rich State and aid as protectors of man and beast, and also the home and grain, from the cold, northern blasts and the hot, destroying winds from the south. I predict all sensible farmers—and we have no others in North Dakota—their wives and children, will endorse and aid the Sylvaton movement, which cannot but prove advantageous to the State and all classes of its citizens.

As a farmer, I endorse all the objects of the Sylvatons, and the system under which they operate. But I will speak in particular of two things: The almost entire number of the school houses scattered throughout the State are unfenced and unsheltered by trees or bushes. This, I consider a disgrace to the State and discreditable to our people. For this reason I heartily commend your Sylvaton Idea to fence school grounds, which, as you contend, should be enlarged, and to adorn the same with trees and shrubbery. And it is also most desirable to have a well of good, pure water upon the premises, and the well should be well protected and cleaned out at proper times, so the water may be kept wholesome for the pupils and teachers.

I am glad, also, that the Sylvatons advocate irrigation, for without water or moisture no trees can be raised in any state or nation of the globe.

Zealous for forestry and hence for the best interests of the State, I am, Yours respectfully,

HENRY ZIMMERMAN,
Farmer.

THE STUDY OF NATURE AWAKENS LOVE FOR ITS RULER.

LAKOTA, N. D., Dec. 10, 1894.

Hon. W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—I believe that the Sylvaton societies being organized on your recommendation are going to be of great and lasting benefit to North Dakota. If only a few of the many worthy objects of these societies should be accomplished, the organization would be well worth all time and thought spent upon them. The idea of interesting the school children in the study of forestry is one that cannot be too highly commended. The cultivation of a love for nature in the young is next to the cultivation of a love for the Ruler of nature. Respectfully,

W. T. CAMPBELL,
Principal of Lakota High School.

SUFFICIENT TREES AND MOISTURE GIVE BEST CONDITIONS FOR AFFLUENCE AND PLEASANT HOMES.

IRVINE, Benson County, N. D., Dec. 14. 1894.

W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—Of the many economic questions and systems which have received your attention for a number of years, I consider the Sylvaton Idea deserving of special consideration, for if the children of the State are taught to plant and cultivate trees, when grown to adult age they will make a fuller application of their knowledge, and so change our open plains that sheltering timber and leafy groves will adorn the landscape far and near, for the contentment, comfort and happiness of the people.

I commend your idea of fencing the school grounds and the creation of groves or parks thereon. These pleasant surroundings will have a salutary effect upon the young, and prove an ornament to the country and a pride to the community. Give us sufficient trees and moisture, and North Dakota will become the most desirable land for those who seek the best conditions for affluence and a pleasant home. Yours in behalf of forestry,

A. E. SYLVESTER,
North Dakota Farmer.

A BENEFIT TO PRESENT AND FUTURE GENERATIONS.

DEVILS LAKE, Dec, 12, 1894.

W. W. Barrett, State Superintendent of Irrigation aud Forestry, Church's Ferry, N. D.:

DEAR SIR:—I heartily commend the North Dakota Sylvaton Idea, originating with yourself. If this idea is made operative, as it doubtless will be, in practical application in North Dakota, the states and nations of the world, it will enhance the wealth, comfort and happiness of present and future generations.

As a veteran teacher, I extend sympathy and pledge co-operation in the good work, involving some of the best and dearest interests of the State and the masses. Yours sincerely,

D. G. DEUELL,
County Judge of Ramsey County, N. D

THE FORESTATION OF THE STATE IS OF PARAMOUNT IMPORTANCE.

CHURCH'S FERRY, N. D., Dec. 12, 1894.

W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—The Sylvaton Idea, or the engagement of the children of our State schools in the subject of forestry, which we know has occupied your attention for many years, is deserving of the most sympathetic encouragement from all school officers and teachers and the community at large. We are pleased to endorse your entire Sylvaton system, but would commend in particular the great importance and advantages of fencing the school grounds and the planting and cultivation of trees and shrubbery thereon. Such environment would exert the most favorable influences, tending in a high degree to ennoble character and develop the higher nature of mind and heart.

The forestation of the State is of paramount importance and the enlistment of our school children in the undertaking cannot but hasten the same for the benefit of the State and the present and the future generations. We commend and stand ready to aid all the worthy and beneficent objects of the Sylvatons.

HENRY A. NOLTIMIER,
President School Board of Coulee, Ramsey County, N. D.
MRS. CLARA L. NOLTIMIER,
Treasurer School Board of Coulee, Ramsey County, N. D.
H. A. MOE,
Clerk of Board, Coulee, Ramsey County.
C. F. SCHULTZ,
School Director, Coulee, Ramsey County.
W. A. DAVIS,
Principal of School, Church's Ferry.
G. HILLERMAN, Teacher.
MISS LIZZIE DINGMAM,
ELLEN J. MITCHELL,
EMLEY MITCHELL,
Teachers, Penn.

"I BID YOU GOD SPEED IN THIS MOST COMMENDABLE UNDERTAKING."

UNIVERSITY, N. D., Dec. 12, 1894.

Hon. W. W. Barrett, Commissioner of Forestry and Irrigation:

DEAR SIR:—Your plan of enlisting the school children of this State in the commendable work of planting trees and shrubs about the school grounds, the home yard and the public roadside, commands my warmest approval. Few reminiscences of my school life are more delightful than the memory of the noble elms which adorn the Yale campus. I have long been a firm believer in the high educational value of natural scenery. We can not, it is true, command, in North Dakota, the green hills and granite peaks of New England, but there is no reason why, with the host of North Dakota school children to back the movement, we can not have, in time, as noble elms to grace our school grounds and home yards as are found on the Yale and Harvard campus, or among the famed Berkshire hills of western Massachusetts. The presence of such giants of the prairie will, in large measure, compensate for the absence of the hills. I bid you God speed in this most commendable undertaking. Very truly yours,

WEBSTER MERRIFIELD,
President of the North Dakota State University.

FORESTRY DESERVING OF COMMENDATION.

Hon. W. W. Barrett:

DEAR SIR:—The cause of forestry in America has enlisted the enthusiastic support of botanists, meteorologists, economists and hosts of other workers concerned in the preservation of the forests, which were being ruthlessly destroyed.

There is some hope to be gleaned from this general awakening to the necessity of cultivating and protecting the forests of the country, and any intelligent endeavor to increase the interest of our citizens, young or old, in this question is deserving of commendation. In the category of such efforts we may place the State Sylvaton society.

MELVIN A. BRANNON,
Professor of Biology at North Dakota State University.

MAKING THE CHILDREN FAMILIAR WITH THE FLORA OF THE STATE.

Mr. Barrett has originated the idea of the Sylvaton society, interesting the school children in collecting seeds and fruit and making them familiar with the flora of our State. Mr. Barrett has been untiring in the work, and we can but admire his industry and the results he has accomplished. Sincerely yours,

EMMA C. CRANE,
Secretary of the North Dakota State Sylvaton Society.

DOING AN EDUCATIONAL WORK.

GRAND FORKS, N. D., Dec. 14, 1894.

In establishing the Sylvaton society, Mr. Barrett is doing an educational work for which we should all be grateful. He is teaching the children to observe the plants native to the State, and is encouraging a pride in our forestry possibilities. He deserves the co-operation of parents and teachers.

Very sincerely,
CORA SMITH-EATON, M. D.

WILL MAKE NORTH DAKOTA NOT ONLY THE SYLVATON STATE IN NAME BUT IN REALITY—A TREE MANUAL FOR SCHOOLS.

DEVILS LAKE, N. D., Dec. 13, 1894.

Hon. W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—You are, indeed, to be congratulated upon being the originator of the Sylvaton Idea and in so far securing recognition upon its merits by the World's Fair officials as to receive an award upon the important feature of interesting the young people of the State in the matter of forestry. This idea, so thoughtfully formulated by yourself, if put to a thorough and practical demonstration, will make North Dakota not only the Sylvaton State in name, but in reality.

It is to be regretted that the American people are not yet sufficiently impressed with the necessity of speedy measures for the preservation of our natural forests and the planting and cultivation of artificial ones upon our treeless plains and prairies. Constant and vigorous agitation will be required to bring public sentiment to the point where it will demand proper remedial measures to improve present conditions.

Yes, even more than that, we must so instruct our children that each succeeding generation shall be eager to adopt improved methods for increasing and preserving the forests of our State. I know of no subject that presents alike to teacher and pupil a more interesting, practical and important field for incidental study than this far reaching department of forestry. The child can readily be taught how forests influence the rainfall, temperature, evaporation, winds, climate as a whole, and the opposite effects upon the same by forest destruction. By way of illustration, he will not fail to be interested in the story of the desolation that has fallen upon parts of India, Greece, Turkey, Egypt, Italy, Spain, Palestine and even many portions of our own country, following the destruction of the forests in once favored localities. Instructed in the wonders of plant life, the boys and girls will understand how trees and plants grow, with what elements they are nourished, and how they arrest pestilence by consuming gases poisonous to animal life.

The species of tree indigenous to our State, their seed and fruit products, the collection of specimens for the school museum, a consideration of the vast annual consumption of wood for fuel, building and manufacturing, and the articles manufactured therefrom, will furnish sufficient material for many a valuable lesson. In correlation with the above, attention can be given to our birds and insects, and their important part in nature's economy. All this, it seems to me, could be compiled in a manual in the form of simple lessons in rudimental forestry, prepared with special reference to our own State. Such a guide could be placed in the hands of the teachers to supply them with valuable matter for presentation to the pupils in general lessons, or otherwise, as opportunity might permit, and I believe such a plan would meet with hearty co-operation among the educators of the entire State. With such elementary instruction imparted in an interesting and attractive manner, by experiments, illustrations, object lessons, etc., the practical work designed to be carried on by the Sylvaton organization would not suffer for the want of willing hearts and ready hands to enlist in its membership and active operations.

In connection with the schools, I would add that every school house in the State should be fenced to insure protection to trees and flowers upon the school grounds. Trees can not be successfully grown until this is done. The tree is a blessing, not only to us, but to the men and women of the future. We should no longer be careless of that future, lest our posterity may curse our reckless improvidence. May success attend your labors.

Yours respectfully,

L. B. Fancher,

Superintendent of Ramsey County Public Schools and Vice President of the North Dakota State Sylvaton Society.

I trust the suggestion made by our able and honored educator, Prof. Fancher, for the use of a tree manual for our schools will meet with general favor. Since receipt of Prof. Fancher's letter a committee has been appointed to prepare such a work, which would, without doubt, result in much practical good to the schools, the people and the commonwealth.

THE ADVANCEMENT AND PROTECTION OF THE HOME PLACE AND THE SCHOOL HOUSE.

Lakota, N. D., Dec. 8, 1894.

W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

Dear Sir:—The Sylvaton Idea, or the enlistment of the school children of the State in the question of forestry, which system originated with yourself, and has received much attention at your hands for a number of years, is a matter of so much importance that it is worthy of the earnest support and encouragement, and will doubtless receive the same, of all teachers and parents, who desire the best good of the scholars themselves, and the advancement and protection of the home place, the school house and all parts of our State where trees and forests are needed.

Hannah H. Holton.

LET THE SCHOOL SITES BE ENLARGED, FENCED AND BEAUTIFIED.

Church's Ferry, N. D., Dec. 13, 1894.

W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

Dear Sir:—In common with all lovers of nature and those who have our country's highest interests at heart, I cordially endorse your Sylvaton Idea.

Especially do I commend the idea as it is being connected with our schools, since in the proper education of the youth of our land depends to a great extent the future of our great and glorious commonwealth.

The plan of fencing and improving our public school property should meet the hearty approval of all parents, teachers, and all connected in any way with our schools.

The Sylvaton celebration of Arbor Day is, in my humble opinion, one of the most beneficial and preservative features of the whole plan, and one to be heartily endorsed by all schools and teachers throughout our land.

Let the schools sites be enlarged, fenced and beautified, and they will exert still more and more an elevating and educating influence over the young and rising generation.

Most cordially and respectfully yours,
W. A. DAVIS,
Principal of the Church's Ferry Village School.

IRRIGATION AND FORESTRY INTIMATELY CORRELATED.

LAKOTA, N. D., Dec. 8, 1894.

W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry. N. D.:

DEAR SIR:—Your concise and comprehensive Sylvaton Idea is one worthy of the best attention and endorsement of all teachers, and all who would train the young in those practical things of life which conduce to their own welfare and the community at large.

Whilst the idea of imbuing the young with a love of, and an engagement in, forestry has been advanced from time to time, it has been left to you, as a citizen of our State, to offer a plan by which the same may be put into execution. Each object sought by the Sylvatons meets with my unqualified endorsement, as each one is of great importance. But with pleasure I refer to a few which impress me as worthy of most considerate attention.

You advance the idea that irrigation and forestry are intimately correlated. If this fact could be more fully understood it would be better for the people who need light upon those things that conduce to their best good. The idea is not mere theory, but observation proves the correctness of the proposition. Water properly applied in form of irrigation makes a certainty of tree growth, and trees in turn tend directly or indirectly to promote precipitation and to conserve the water, to be used when needed. Thus we discover the beautiful law of inter-relationship of these two important factors which are essential to balance and hold in true relationship the things of nature, out of which accrue the most favorable results in agricultural and horticultural industries!

The World's Columbian Fair was but one vast object school, where was seen the things of nature, science and art, and the many lessons there taught were mighty in their results. The principle is the same on a smaller scale. You advocate the creation of a cabinet or musuem in connection with every school, where the woods and their fruit, in way of seeds, nuts, acorns and wild fruit, shall be displayed, giving the place where found, the common and scientific name, the name of the collector, etc. To these are to be added mineral and botanical specimens. In this manner the children are taught more effectually than from books, in that the sense of sight preceive the objects as they really exist, and that, too, without weary study, or great loss of time. The natural result of such museums is to train in the young the habits of close observation and to examine more closely the works of nature.

Too much cannot be said in favor of the enlargement of the school grounds, the provision for healthy water and pure air, and the planting of trees and shrubbery, converting the premises into dark-like groves, or parks themselves, where the environment have an influence conducive to the culture of the best nature of mind and heart. Thus the school becomes sacred, dear and ennobling. These things, with the sweet enchantments and love found in the embowered home, and the lessons taught by the extended landscape, adorned with trees, fruit and grain, cannot but imbue our young with a desire to improve character, and fit themselves for the highest practical duties of life, making self, others and country better through Sylvaton principles advocated and upheld in their childhood days.

HENRY D. FRUIT,
Teacher.

GOOD WORDS FROM THE YOUNG SYLVATONS.

* * * All honor and praise to Hon. W. W. Barrett for the labor he bestowed and the interest he displayed in the Sylvaton organization. * * * We hope Sylvaton societies will be organized in many schools of our land, to the end that a live and yearly increasing interest may be aroused in the glorious work of tree planting and decorating our school houses and grounds with trees, plants and flowers.—*Sadie Murphy, Ora Bullock and Cornelia Chambers, Sylvatons of the Church's Ferry School.*

WILL TRY MY BEST.

SYLVATON RANCH, COULEE, Ramsey Co., N. D., Dec. 2, 1894.

Hon. W. W. Barrett, State Superintendent of Irrigation and Forestry, Church's Ferry, N. D.:

DEAR SIR:—I am glad you started up the Sylvaton Idea. Now we, the children of North Dakota, can work for the cultivation of forest trees, and the wild fruit. I believe in the Sylvaton movement, and I will try my best to help the good work. All my brothers, and sisters, and mother, too—she is honorary, our dear mother—are members of the Sylvaton Ranch Home Sylvaton society, and we are just full of vim and joy in making the collection and putting up the seeds, nuts, wild fruit and grain. We put them in glass bottles. Everything is done very carefully and nice, for we are bound to have a cabinet that everybody will delight in. Last fall we boys gathered wild plums and hazel nuts, and these we have put up, and also some beans and citron seeds that we raised, though mother helped us, in our garden last year.

We are getting ready for a big Sylvaton celebration next Arbor Day. We now have some nice mottoes for our flags. One is "Loyal Sylvatons, Loyal Patriots."

Now I must stop and go out and do my chores.

Yours respectfully,
ALEX. STAMM,
President of the Sylvaton Ranch Home Sylvaton society.

A NEW RACE OF FORESTERS WILL APPEAR.

It is clear to the understanding of all who have investigated the Sylvaton Idea, or the enlistment of the children of the State in the question of forestry, that it is replete with golden promises to the coming generation, for if the leaders of thought shall fully develop the Sylvaton system, a new race of foresters, limited to no state, nation, or clime will appear in due time to clothe the barren prairies, mounts and hills of our earth with leafy foliage. Thus riches and blessings will come unto the human race, especially in those lands where such foresters may manifest their love and knowledge of tree-culture wherever the same may be needed.—*Church's Ferry Sun.*

"ALL ARE HEARTY IN THEIR APPROVAL."

* * * All are hearty in their approval of this step, and evince a deep interest in the work. Commissioner Barrett is to be commended for the earnest and efficient service that he is doing for the State.—*Lakota Observer.*

"THE HEARTIEST ENCOURAGEMENT."

The object of the movement is to reduce to careful system all efforts in the line of beautifying our school grounds with hardy shade trees, orchard trees, shrubs and small fruits, such as the ripest experience of careful experimenters have proved suitable to these prairies. No doubt the Sylvaton society idea offers an intelligent and highly practical method of turning the monotony of the pristine prairie into variagated landscapes, and object lessons for those of us who desire the information along these lines but can not experiment sufficiently for fullest test alone.

Heartiest support and encouragement for Mr. Barrett.—*Lakota Herald.*

THE SYLVATON IDEA IS AN ADMIRABLE ONE.

The Sylvaton Idea is an admirable one, and was happily suggested, or more properly, renewed by Superintendent Barrett's success in securing an exhibit of forest tree seeds for the World's Fair, the collectors being exclusively the school pupils. It will be remembered that the exhibit won an award of merit and medal at the Columbian Exposition. It is proposed to effect organization in every school district where possible, these organizations to be auxiliary to a State society.

The Farmer hopes Superintendent Barrett's project will meet the encouragement it deserves, and that all school officers will heartily co-operate in the work. The movement contemplates general organization throughout the State, and this will be necessary to secure the success hoped for.—*North Dakota Farmer.*

ESPECIALLY PRACTICAL AND DESERVING OF PRAISE.

Hon. W. W. Barrett has an interesting article in the Grand Forks Herald of the 23d inst., in relation to the Sylvaton societies which he has been organizing throughout the State. In a prairie state like North Dakota anything which tends to creat an interest in forestry is to be commended, and Mr. Barrett's idea of enlisting the sympathies and active co-operation of the school children in this great work is especially practical and deserving of praise.

ENDORSED BY MEMBERS OF THE AMERICAN FORESTRY ASSOCIATION.

The American Forestry Association, one of the most useful co-operative bodies in the world along the line of practical reforms and needful developments, it is pleasant to note, has caught the spirit of the western idea, and many members thereof are lending aid and advocy of the project. In a recent address Geo. W. Minier, vice president of the American Forestry Association, says:

"I want to see the planting of trees, the care of trees, and the preservation of trees go on until it penetrates the nation; until taught in every school from the public to the university, and cherished in every household."

He would add to our common school curriculum, he states, "the art of tree-planting. I want this noble and refined art begun in childhood and fostered in families."

And Mr. Minier continues: "Let us encourage tree planting as well as tree preservation in children, in families, in schools of every grade; the public schools in particular. There nineteen-twentieths of the people get all the education they ever get in schools. Our common schools, therefore, are nineteen times more important to us, as a nation, than our colleges and universities."

FORESTRY IN OUR COMMON SCHOOLS AND COLLEGES.

I have read with interest and instruction in the publications of the American Economic association for May, 1891, the valuable papers of Mr. Fernow, Mr. Pinchot and Mr. Bowers, and I wish these could be placed in the hands of all our people. These papers, and others like them, could be made the basis of instruction in our common schools and colleges. They present the American view of the question of forest administration in a lucid, convincing way and entirely overthrow the ignorant assertion of some, that the subject of forestry is a hobby, or, at best, an entertaining theme for enthusiasts or sentimentalists.—*Hon. John W. Noble, Ex-Secretary of the Interior.*

ADVANTAGES OF A SCHOOL PARK.

Mr. Jacob Riis says in a recent article: "If I had my way, I would surround every school in the city, uptown or downtown, with a park that would make it always the most attractive spot in all the neighborhood. To my mind that is one of the chief advantages to be derived from the school park. Instead of being repelled, children would be attracted to a school that was identified with their play-ground. Truancy would cease. I would adopt the plan that has proved successful in London, of lending the schools to the boys for club rooms in the evening hours—under some system of effective but not intrusive surveillance, and not the kind that would aim at 'keeping them down'—those evening hours when the manufacture of the tough goes on most actively in the street. The gangs would soon find their occupation gone when the schools became boys' clubs."

"THE TRUTH IS POTENT."

"The truth is potent, the knowledge of trees, their utility and the art of tree planting should be taught in our public schools."—*Geo. W. Minier.*

CHAIRS OF FORESTRY IN OUR COLLEGES.

Mr. Met. L. Saley, in the Northwestern Lumberman, writes on the subject of chairs of forestry in every college and university, and closes his article with this excellent paragraph:

"A professor of forestry should not alone teach how to manipulate timber in order that the greatest possible amount of money may be gotten out of it. This is one, and an important phase, but does not exhaust the subject by any means. People generally should know one tree from another, the uses for which various woods are adapted, the kind of soil in which the different trees will grow and how they should be planted and cared for, and I may say above all else, the part they play in the economy of nature in making our lives pleasant and happy. In brief, we should be taught to love trees. General treeology, if the name be permitted, is what should be taught, and I would that the knowledge might be instilled in the minds of the pupils so thoroughly that when, in turn, they go out in the world as teachers, business or professional men, they would keep the ball rolling. Believe me or not, as you have a mind to, a hundred years hence trees will be a thousand times more precious in the eyes of the inhabitants of America than they are to-day."

WORLD'S COLUMBIAN COMMISSION EXECUTIVE COMMITTEE ON AWARDS.

John Boyd Thacher, chairman, Albany, N. Y.; W. J. Sewell, New Jersey; A. T. Britton, District Columbia; A. B. Andrews, North Carolina; B. B. Smalley, ex-officio member, Burlington, Vt. Bureau:—Pacific building, 622 F. street, Washington, D. C.

WASHINGTON, D. C., April 24, 1894.

DEAR SIR:—I herewith enclose you an official copy of your award which, in due time, will be inscribed in the diploma and forwarded to your present address, unless otherwise indicated by you.

Yours,
JOHN BOYD THACHER,
Chairman Executive Committee on Awards.

UNITED STATES, DEPARTMENT "N."—FORESTRY.

Exhibitor—W. W. Barrett. Address, Grand Forks, N. D. Group 19. Class 113. Exhibit—Collection of seeds of forest and fruit trees.

AWARD.

Exhibited as the work of the children of North Dakota, supervised by Mr. Barrett as the State Superintendent of Forestry; 40 kinds of seed are shown, 19 of which are from wild fruits. The work, of which this exhibit is the result, is well calculated to promote a better appreciation of the principles of forestry.

(Signed)
ROBERT N. HUDSON,
Individual Judge.
Approved. S. SUWA,
President Departmental Committee.
JOHN BOYD THACHER,
Chairman Executive Committee on Awards.
Date, April 7, 1894.

"IN THE MANUSCRIPT OF GOD."

Would you, oh, Sylvatons, learn of Nature and of the Loving Father above? Then go out on your annual excursions, or oftener, and study and enjoy the woods, the hills, the dales and the brooks, that like yourselves, leap and dance and play in merry glee the wildwood sweeping through, where "the sisterhood of flowers" give sweets and beauty rare, and the warblers chant their praise.

There play, and think and pray and sing, the gladsome songs the poet may give to you.

And Nature, the old nurse, took
The child upon her knee,
Saying: "Here is a story book
Thy Father has written for thee."

"Come, wander with me," she said,
"Into regions yet untrod;
And read what is still unread
In the manuscripts of God."

And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvelous tale.—*Longfellow*.

A SUMMARY RECAPITULATION.

In closing my report to you as the chief executive of our commonwealth, and one who without doubt has sought the best interest of the State and the people, I take great pleasure in acknowledging my obligation to you for the uniform courtesy and sympathetic aid, as was true of your predecessor, by which I have been strengthened and enabled to carry on, with some degree of success, the affairs of this department, covering numerous branches, all of which are of vital importance to the best interests of the State and the people. And, Sir, I trust it is but proper on my part to indicate to a limited extent, the motives that have prompted and the aims which I have had in view. I came, like yourself, to make North Dakota my home and I am satisfied our State contains all the elements necessary to make it the

LAND OF PLENTY AND HAPPY HOMES.

But there are certain economic questions that demand a solution. But these questions to which I will refer are not restricted to our commonwealth alone. They are the identical problems that are up for a solution in all states of our union, and all nations of the globe, to-wit, sufficient moisture, when and where needed, for an assurance of annual and plentiful and profitable crops of agricultural and horticultural productions, and sufficient trees and forests for the proper balancing of the forces of nature, and for the necessities, protection, comfort and happiness of the people. Realizing the importance and absolute necessity of these two economic factors in their right proportions, my motives have been for many years to assist in discussing the questions and using these elements in such a manner that the best possible results may be obtained compatible with existing circumstances.

THE TRUE MEANING OF IRRIGATION.

An erroneous impression has prevailed to a greater or less extent, that irrigation consists only in the application of water found on or below the earth, to the ground, for the increasement of cultural pursuits. That is a very important and indispensable part of irrigation. But irrigation, in its true comprehensive sense, and as indicated by the law creating the office of the State Superintendent of Irrigation and Forestry, involves moisture in all its forms and places, whether in the sky, on or in the earth; its nature, its laws of action, its functions, and its use in practical application, especially in promoting the growth and maturity of the fruits of the earth. And through the press and in other public ways, and in my reports, my aim has been to conduct an *educational work*, with a view of enlarging the idea of irrigation and forestry to their legitimate bounds; to prove their intimate correlation and inseparability, and to make clear their absolute and indespensable necessity in the economy of nature and in the husbandry of life. Nor is this all by any means. I have sought to teach and unfold such practical systems, and to suggest such modes of action as will tend to secure the most desirable and practical results from their proper development. Thus far, judging these things in the light of current events, good progress has been made. But it must be remembered much of this work has been preliminary, and such work, if properly managed, is just as necessary as what may be termed the direct application of the systems—before the grain crop there is the breaking, harrowing and seeding, all necessary in order to secure the bountiful harvest, —which in these things will surely come in due time to North Dakota, under proper management, in the form of large areas of trees and forests and practical and profitable irrigation systems.

LEADING FEATURES OF THIS REPORT.

In this report I have given all the State laws relative to irrigation and forestry; a condensed history of these two systems in our State; pointed out the intimate and inseparable correlation or intercorrelation, and mutual dependencies of irrigation, forestry and agriculture, all subject to, and influenced by, the natural laws and elements coming under the general name of meteorology, such as light, heat, air, moisture, electricity, etc.; enlarged the idea of irrigation to its proper and legitimate bounds; pointed out with considerable care the probable source of our artesian supply, or the supply to the Dakota basin of the two sister states; the immense amount of rainfall in the semi-arid west, the source, to a great extent, of our underground waters; described the nature, extent and boundaries, as far as can be learned to date, of our artesian basins, covering probably most of our entire State; gave a condensed but full description of the James river, or the Dakota artesian basin of the two Dakotas, the largest and most wonderful artesian basin in the world; the extent of the artesian developments; the kinds and number of flowing artesian wells, 672 in the State; their location, depths, geological strata, flowage, pressure, etc.; the quality of their waters; pointing out how the same may be fitted for plant growth; the certainty of crops, their great increase and the very great profits that result from irrigation from waters furnished by artesian wells. I have also pointed out where irrigation plants can probably be worked to profitable advantage, the source of supply being from lakes, streams, etc.; made known where large underflows but a few feet below the surface of the ground, 8 to 12 or 15 feet, can be found; and how these thousands of acres of land can be successfully irrigated by means of windmills; pointed out the importance of raising forests on our water sheds in order to save the utter loss of our lakes, and to prevent the drying up of our rivers.

I have also given a treatise, copious but condensed, of the windmill irrigation system which I have advocated for many years, pointing out its possibility and its adaptability to North Dakota, the clearly ascertained advantages of the system and the profits to be derived therefrom. I have presented many facts bearing upon the subject, and proved by undoubted testimony that it is practically successful in Kansas (where, in one county alone, 125 of such plants are in successful operation) and in other western states. This system of irrigation is worthy of careful consideration, as it seems eminently adapted to our conditions in North Dakota.

OUR FORESTRY DISPLAY AT THE WORLD'S FAIR.

I have described our forestry exhibit at the World's Columbian Fair. It was of such a nature and so well and attractively displayed that it made a most favorable impression upon the minds of the thousands who daily thronged the great Forestry building. The two North Dakota Sylvaton towers, with their fine collection of forest seeds, nuts, acorns and wild fruits of our State, were amongst the chief attractions of the world's vast collective exhibits of forestry, and because of superiority in all points of excellence two awards, a diploma and a medal, in both cases, were adjudged to our State, whilst some states received no awards, and some only one on their forestal display.

THE SYLVATON EDUCATIONAL FORESTRY WORK.

In a few years hence our school children will be the men and women of the State. Hence, carrying out, according to my long-cherished plan, the educational forestry work, I have been instrumental in organizing the Sylvaton Idea, or the enlistment of the school children of the State in the subject of forestry. The full outline of the system and progress made is given in this report.

A TEXT BOOK.

My aim has been to make this report a text book. It contains many valuable facts and many useful tables, and data relating to forestry, artesian wells, surface water and windmill irrigation, etc. Specific and careful instructions are given as to the procuring and saving of forest seeds, cuttings and seedlings, their proper planting, culture, care and protection of the trees, and what trees are best adapted to our soil and climate. And clear and distinct rules and instructions are given for the proper and profitable management of irrigation systems adapted to our conditions in North Dakota. And many other valuable features are added, thus making this work of much value to those who may need information upon these subjects in their experimentations and operations along these lines.

OUR FORESTRY DEPARTMENT.

I have also given a list and the sizes and location of our native trees, bushes, vines and wild fruit. I am highly gratified at the discoveries made to date in the investigation of the forestry of our commonwealth. I find we have near 460,000 acres of native forests and near 40,000 acres of cultivated trees, making near half a million acres of timber land in our prairie State. We have 50 varieties of trees, 18 bushes and 10 creepers and vines, all of which are natives of our woods. Our native wild fruits consist of 20 varieties, all of the very best quality, and all capable of successful domestication, and the crop of the fruit of our forests, native and domestic, in form of forest seeds, nuts, acorns and wild fruit, would, on an average, be sufficient to make many carloads, and long trains each returning year.

THE DUTIES OF MY OFFICE HAVE CONSUMED MY ENTIRE TIME.

The duties of my office have been great and my correspondence extensive and these have demanded and received my entire time and undivided attention.

My duties as State Commissioner of Fish and Game have claimed much of my time and care.

DIFFERENT OFFICES WISELY COMBINED IN ONE.

Other states have similar departments to this one of our State, except the different branches are represented separately. Thus Ohio, New York, Pennsylvania, Maine, Colorado, California, and other states have forestry commissioners, and South Dakota, Colorado, Wyoming and other western states, have superintendents or engineers of irrigation, but our law-makers wisely combined the two offices in one for the sake of economy, and because irrigation and forestry, as stated above, are inseperably correlated.

The operations and success of this department of our State service are watched with deep interest by the other states of the union, wherein the subjects of irrigation and forestry are receiving new and earnest attention, and the letters received from leading men of the nation are commenatery in the highest degree, stating it is most creditable to North Dakota, as it is an admirable way of bringing to view the great natural resources and possibilities of the new State.

Our forestry exhibit at the World's Fair, and the awards received there, and because of their superior merits, have placed our State before the people of the union and the nations of the earth in that light which we, by right, are unquestionably entitled to. These forestal displays at the great exposition in connection with our grain, grasses, vegetables, and other exhibits, have demonstrated that it is the "fittest" State of the west for the emigrants, who, thus enlightened, will seek our borders, and increase our developments and prosperity.

And the usefulness of this office, I trustingly believe, is fully appreciated by our own wise, generous people.

These facts, and many more that could be named, are sufficient to indicate the importance and value of this department, and that all proper aid and appropriations should be made to increase the work for the benefit of the commonwealth and the people.

This department should be made more serviceable to the State and its citizens. The State Superintendent of Irrigation and Forestry should do this: Devote much of his time in visiting various parts of the State to give instruction or furnish needed information to those contemplating an engagement in irrigation, and the planting of more trees, etc. He should be allowed to send out bulletins and circulars to the people, giving necessary information upon these subjects. In this and other ways the usefulness of this department can be materially increased.

THE FIRST STATE FORESTRY SCHOOL OF THE WESTERN CONTINENT.

Herein I have referred to the North Dakota State School of Forestry. A State School of Forestry for different states has been advocated by writers and statesmen for many years, especially of the present time. Some years ago, it will be remembered by the old western settlers, General Andrews, of Minnesota, introduced a bill in Congress for such a school, but his measure failed to carry.

It is worthy of remembrance, as a historical fact, though such a school has been contended for through the centuries, North Dakota is the first and only state to establish such an institution on this, the western continent.

This school can and should be made the greatest forestry, irrigation, meteorological and scientific school in America. Hence its foundation should be laid on broad lines upon which to build the new economic institution of the new enlightened age.

Though our State has a depleted treasury, nevertheless, as the things sought to be taught by this school, are of paramount importance, and concern the best interest of the people and the honor and credit of the State, it would seem wise to arrange for the establishment of the same, together with a small appropriation for the commencement of the institution. This is a subject worthy of the thoughtful attention of our legislative assembly.

FORESTRY IN OTHER COUNTRIES.

For the sake of comparison and encouragement, I have given a condensed statement of the status of forestry in the old world, where it is managed intelligently and with a very great profit to the different nations.

COURTESIES OF TRANSPORTATION LINES.

From a sense of duty and with much pleasure I record the fact that the transportation lines, the railways and express companies of our commonwealth have rendered most efficient and valuable aid, free of charge, to this department in way of transportation of forestry specimens, woods, seeds, etc. Without these courtesies this department would have failed in the accomplishment of those things, which have been most creditable to North Dakota.

And I will add more: The same favors have been extended to all other products of our State, in that the entire exhibit of North Dakota, in the preparation of the same for the World's Fair, were carried free of expense within the borders of North Dakota. These things clearly indicate our public carriers are not unmindful of the best interests of the State and the masses.

RECOMMENDATIONS.

In accordance with the law under which I operate, I hereby make the following recommendations:

That laws be passed by our Legislative assembly for the following purposes:

Provide a deputy with a suitable salary for this department.

Give the State Superintendent of Irrigation and Forestry the right to issue bulletins treating of the things pertaining to his office, to be issued when he may deem the same will prove of service to the people.

That a law be passed creating a Commission of State Irrigation, of which the State Superintendent of Irrigation and Forestry shall be *ex-officio*, a member whose duty shall be to investigate the question of irrigation, in its various phases, and learn of the extent and volume of our underground waters, where they exist, and what systems of irrigation can be made successful in our State, and that said commission shall make its report to the Governor of our State for the benefit of our next then succeeding Legislative assembly. The object of this commission is to learn of the practicability of irrigation in our State, and what action is necessary to be taken in order to secure a title to the 1,000,000 acres of land that the Federal Government has given to North Dakota for irrigation purposes.

That a law be passed making wise provision for the establishment of the State School of Forestry.

GOVERNMENT LANDS FOR IRRIGATION PURPOSES.

Since finishing this report, I have received a copy of the law by which 1,000,000 acres of government land is given, under certain restrictions, to North Dakota for irrigation purposes. It appears below.

[PUBLIC—No. 200.]

An Act making appropriations for sundry civil expenses of the government for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby appropriated for the objects hereinafter expressed, for the fiscal year ending June thirtieth, eighteen hundred and ninety-five, namely:

SECTION 4. That to aid the public land States in the reclamation of the desert lands therein, and the settlement, cultivation and sale thereof in small tracts to actual settlers, the Secretary of the Interior with the approval of the President, be, and hereby is, authorized and empowered, upon proper application of the State to contract and agree, from time to time, with each of the States in which there may be situated desert lands as defined by the Act entitled "An Act to provide for the sale of desert land in certain States and Territories," approved March third, eighteen hundred and seventy-seven, and the Act amendatory thereof, approved March third, eighteen hundred and ninety-one, binding the United States to donate, grant and patent to the State free of cost for survey or price such desert lands, not exceeding one million acres in each State, as the State may cause to be irrigated, reclaimed, occupied, and not less than twenty acres of each one hundred and sixty-acre tract cultivated by actual settlers, within ten years next after the passage of this Act, as thoroughly as is required of citizens who may enter under the said desert land law.

Before the application of any State is allowed or any contract or agreement is executed, or any segregation of any of the land from the public domain is ordered by the Secretary of the Interior, the State shall file a map of the said land proposed to be irrigated, which shall exhibit a plan showing the mode of the contemplated irrigation and which plan shall be sufficient to thoroughly irrigate and reclaim said land and prepare it to raise ordinary agricultural crops, and shall also show the source of the water to be used for irrigation and reclamation, and the Secretary of the Interior may make necessary regulations for the reservation of the lands applied for by the States to date from the date of the filing of the map and plan of irrigation, but such reservation shall be of no force whatever if such map and plan of irrigation shall not be approved. That any State contracting under this section is hereby authorized to make all necessary contracts to cause the said lands to be reclaimed, and to induce their settlement and cultivation in accordance with and subject to the provisions of this section; but the State shall not be authorized to lease any of said lands, or to use or dispose of the same in any way whatever, except to secure their reclamation, cultivation and settlement.

As fast as the State can furnish satisfactory proof according to such rules and regulations as may be prescribed by the Secretary of the Interior, that any of said lands are irrigated, reclaimed and occupied by actual settlers, patents shall be issued to the State or its assigns, for said lands so reclaimed and settled: *Provided*, That said States shall not sell or dispose of more than one hundred and sixty acres of said lands to any one person, and any surplus of money derived by any State from the sale of said lands in excess of the cost of their reclamation, shall be held as a trust fund for and be applied to the reclamation of other desert lands in such State. That to enable the Secretary of the Interior to examine any of the lands that may be selected under the provisions of this section, there is hereby appropriated out of any moneys in the treasury, not otherwise appropriated, one thousand dollars.

Approved, August 18, 1894.